WATERSHED MANAGEMENT AND FISH HATCHERY PRACTICES IN THE PACIFIC NORTHWEST

Y 4.M 53:103-3

Watershed Management and Fish Hatch... ING

THE

SUBCOMMITTEE ON ENVIRONMENT
AND NATURAL RESOURCES

OF THE

COMMITTEE ON
MERCHANT MARINE AND FISHERIES
HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRD CONGRESS

FIRST SESSION

ON

WATERSHED MANAGEMENT AND FISH HATCHERY PRACTICES IN THE PACIFIC NORTHWEST

MARCH 9, 1993

Serial No. 103-3

Printed for the use of the Committee on Merchant Marine and Fisheries

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HEARING ON WATERSHED MANAGEMENT AND FISH HATCHERY PRACTICES IN THE PACIFIC NORTHWEST

TUESDAY, MARCH 9, 1993

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES, COMMITTEE ON MERCHANT MARINE AND FISHERIES,

Washington, DC.

The subcommittee met, pursuant to call, at 10:07 a.m., in room 1334, Longworth House Office Building, Hon. Gerry E. Studds [chairman of the subcommittee] presiding.

Present: Representatives Studds, Hochbrueckner, Unsoeld, Furse, Hamburg, Hutto, Gilchrest.

Staff Present: Will Stelle, Dan Ashe, Cyndy Wilkinson, Laurel Bryant, Lesli Gray, Marv Zeeb, Frank Lockhart, Barbara Jean Polo, Tom Melius, Margherita Woods, Judy Alvarez, Jayneanne Rex.

STATEMENT OF HON. GERRY E. STUDDS, A U.S. REPRESENTATIVE FROM MASSACHUSETTS, AND CHAIRMAN, SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES

Mr. STUDDS. The subcommittee will come to order. People will swim back to their places. Most people outside of this room upon hearing the phrase "A River Runs Through It" would think of a recent movie. Those gathered here this morning, however, think watershed—probably means that most of us don't get out enough, to say nothing of the particularly demented minority amongst us who don't think of either upon hearing that.

If the 1990's are a new age for environmentalism, watershed management is clearly the new age mantra. However, many people, myself included, are uncertain about what the term "watershed" actually means—sort of like managed competition. Other than a river running through it, a watershed seems to be one of those things that no one can define but everyone recognizes when they see it.

We may not hear the thud when the proverbial tree falls in the proverbial forest, but we know that when the proverbial chain saw cuts that tree and everything else along the banks of the stream, that the sun shines through, the water temperatures rise, the stream banks wash out, and the fish disappear. In short, the watershed has been very much affected.

Watershed appears to encompass virtually everything: from land use, to fisheries survival, to pollution control, to drinking water

supplies which is why watershed management is so complicated, why people have tended to either ignore it or put on blinders and focus on an easy answer, and why we have come up short in our current efforts to fix what is wrong with our nation's rivers and streams. We cannot simply focus on the ultimate effects. We have to deal with the multitude of causes. We cannot just look at the water in the river. We have to look beyond the river's banks, and we cannot just grow more fish, especially fat and dumb fish, because that doesn't fix the water quality or habitat problems that killed the first fish.

These issues are why we are here today. We have two distinguished panels of witnesses to explain what it is we mean when we speak of watersheds and to explain why they are so critically important. To help us understand the problems, we will look at the rivers of the Pacific Northwest as a timely case study of the decline of rivers nationwide. According to the American Fisheries Society, these rivers have lost over 100 salmon populations, and an additional 210 are at risk of extinction.

The Columbia River system has gone from one of the most prolific salmon rivers in the world, producing historic highs of 10 to 16 million fish annually, to a river that now supports less than three million fish.

Clearly, we need a new approach to protect our river ecosystems and fish populations from further degradation. Watershed management may be the answer, and our witnesses today will hopefully provide the scientific foundation to coordinate habitat restoration and hatchery practices in a watershed context to support the eventual return of healthy riverine ecosystems not only to the Pacific Northwest but to the entire nation.

This is the first of a series of hearings on the issue of watershed management with the later hearings to focus more sharply on the role of watershed management as a complement to our current regulatory programs to protect water quality and water supplies.

Mr. STUDDS. I particularly want to acknowledge the interest of our distinguished members from the Pacific Northwest to say nothing of the Gulf Southeast over there, and I don't know—maybe it is people who work where we do have a particular affinity for critters who spend most of their energy trying to swim upstream. That is very naturally and instinctively understood on our part. I also want to thank, I gather, the gentlewoman from Washington who may have to replace me as I swim further upstream later in the hearings. Are there opening statements? The gentlewoman from Washington.

STATEMENT OF HON. JOLENE UNSOELD, A U.S. REPRESENTATIVE FROM WASHINGTON

Mrs. UNSOELD. Thank you, Mr. Chairman. As you have indicated, the Pacific Northwest—long recognized for its wealth of natural resources—is fast becoming known for its ongoing controversies over how to manage them. And years of mismanagement have left our forests and fisheries in shambles and our resource-dependent communities in severe financial hardship.

The simple solutions often proposed for these complex problems are also often misguided. In the timber crisis, for example, the focus on how to protect the owl has distracted attention from the real question of how to protect habitat and how to provide for sustainable use of natural resources. The result of the approach has been a species-by-species, crises-by-crises, almost dam-by-dam crises, that has merely promoted further tensions and difficulties in trying to solve the problem.

And our witnesses this morning are widely recognized for their work toward integrated and coordinated solutions to our resource-based problems. I want to welcome them here this morning and particularly Bob Naiman. I think my introduction to him kind of epitomizes some of the problems that we have. We are policymakers, decisionmakers voting on issues sometimes for which we have very, very little background.

And it was in my attempt to find out whether we couldn't be more efficient and do something for the owl and something for fish habitat on the same pieces of real estate that I stumbled across Bob and found that although he had been in contact with the Congress talking to staff (the Appropriations staff) trying to get grant money for research; we, the decisionmakers, often didn't know what work he was doing and, therefore, didn't even know the kind of questions that we should be asking our experts. And so for his help in integrating these problems so that we can have an integrated solution, I am particularly indebted to his guidance.

And I also have very, very much appreciated the advice that we have gotten from John Sayre, a leading voice in the debate over the role of hatcheries in salmon recovery, and I welcome him here also today. I found both of them to be extremely knowledgeable, and I am just delighted that you can share your expertise with the committee. Thank you, Mr. Chairman. I appreciate your dedication to resolving these complex natural resource issues facing the Pacific Northwest and your willingness and desire to take an integrated approach.

Mr. STUDDS. I thank the gentlewoman. The gentlewoman from Oregon.

STATEMENT OF HON. ELIZABETH FURSE, A U.S. REPRESENTATIVE FROM OREGON

Ms. FURSE. Mr. Chairman, thank you for this opportunity to hear what can be done to restore the magnificent salmon of our nation's streams and rivers. Many members of this subcommittee are aware of the crisis that our salmon face. Salmon are an essential ingredient of my district's lifeblood, both for their own sake and for the sake of the salmon fishers.

Until the mid 1980's, most mixed-stock fisheries were managed to harvest the tremendous abundance that Federal and state hatcheries produced, but that bounty came at a price, the loss of spawning and rearing habitat and the decline of naturally spawning salmon populations along the entire West Coast from California to Alaska.

There is really no issue now as to whether fishing regulations need to protect weak natural stocks. Salmon regulations are coordi-

nated coastwide and focus on naturally spawning populations. The issue now is how can we restore naturally spawning populations by addressing the two factors that brought us to this present predicament, habitat degradation and hatchery policy. Today, I trust we will learn how two major elements of the salmon problem can be part of the solution for the resource and the fisheries. I commend you, Mr. Chairman, for the foresight in calling this hearing, and I look forward to hearing from the scientists and innovators we have here before us today. Thank you, Mr. Chairman.

Mr. STUDDS. I thank the gentlewoman. The third of our heavy hitters from the Northwest, the gentleman from California.

STATEMENT OF HON. DAN HAMBURG, A U.S. REPRESENTATIVE FROM CALIFORNIA

Mr. HAMBURG. Thank you, Mr. Chairman and colleagues. What is home? How do you define it? It is a tough question to answer. For salmon, the answer appears easy. Home is the entire spawning watershed and the ocean, but this answer poses yet another question. What is a watershed? The definition of a watershed as a distinct river drainage basin separated from other watersheds by ridge-top boundaries is only the most skeletal beginning.

Today, we begin to explore the interrelationship of activities and conditions which create the home to which salmon return to spawn. As we allow destruction of our watersheds, we destroy salmon populations. And only through a restoration of spawning watersheds can our salmon populations be restored to health. The salmon fishery has historically been one of the major natural resource-based industries in my district of the north coast of California. Today, it is almost nonexistent.

In the last four years, the personal income derived from commercial salmon fisheries in the three coastal communities in my district has dropped to almost nothing. In Crescent City in Del Norte County, the northernmost county of my district, commercial salmon income dropped from 1.3 million in 1988 to $2,000 in 1992; in Eureka, Humboldt County, from 4.2 million to 4,000 in 1992; and in Ft. Bragg, which is in my home county of Mendocino, from 24.5 million to 110,000 in 1992.

I welcome the witnesses today. Your observations and analyses are critical now as we explore how to rebuild the homes essential for the survival of many salmon species. I particularly want to welcome Patrick Higgins from the American Fishery Society in Arcata. I look forward to all of your observations of the Russian, the Eel, the Trinity, and the Klamath Rivers in our home. Thank you.

Mr. STUDDS. Thank you. Does the supremely objective gentleman from Florida wish to make a comment here?

Mr. HUTTO. Mr. Chairman, I would pass. I will just be an observer and watch you swim upstream.

Mr. STUDDS. Here we go. We will turn to our first panel on watershed management. I don't know whether the staff has warned you of the—oh, I will be darned. We have a minority salmon.

Mr. GILCHREST. They call us rockfish, Mr. Chairman.

Mr. STUDDS. A gentleman who also knows something about that direction of the river, the gentleman from Maryland. I apologize. I didn't see you there.

Mr. GILCHREST. That is all right. I don't have any formal statement, but I would like to ask unanimous consent that Mr. Fields's text be entered into the record.

Mr. STUDDS. Without objection.

[Statement of Mr. Fields follows:]

STATEMENT OF HON. JACK FIELDS, A U.S. REPRESENTATIVE FROM TEXAS, AND RANKING MINORITY MEMBER, COMMITTEE ON MERCHANT MARINE AND FISHERIES

Mr. Chairman, it is a pleasure to join with you today in welcoming our witnesses to consider the issue of watershed management and its relationship to water quality and fish habitat.

The Pacific Northwest is facing a regional ecological problem symbolized by the wild salmon. Populations of salmon have been either driven to extinction or greatly reduced, according to a recent study by the American Fisheries Society. Although extinction is usually caused by a combination of factors, loss of habitat is critical and is a major cause of the decline of North American fish. Many have focused on dams as the root of the salmon problem in the Northwest, but other activities may actually contribute to the decline of these species. Forest practices, including road building, have been shown to cause riverine habitat damage, both on and off national forest lands.

Our hearing today will allow testimony to be received concerning the management of our forest lands and ways to improve water quality in rivers, which will benefit fish and other species that habitat these areas.

Mr. Chairman, I join you in welcoming our witnesses and look forward to reviewing the testimony they will provide. Thank you.

Mr. GILCHREST. I also would like to just make a comment about—I am from Maryland so I probably won't be able to stay the whole time the testimony is being given, but I certainly represent a beautiful area of the Chesapeake Bay and understand that if we are to preserve the land and the water and our environment, then watershed management is the way to go, and I look forward to the testimony. Thank you.

Mr. STUDDS. I thank the gentleman. Members of the panel, we will hear you as an entirety in the order in which your name appears. You should be warned if you haven't been: I gather you have been requested to confine your oral presentation to no more than five minutes. Your written testimony will appear in its entirety in the record. We have a brutal Medieval scheme here. Those lights will go on, and when the yellow light goes on, you have one minute left, and when the red light goes on, you have completed your testimony. No one has ever ventured to find out what happens if that is not the case. We will start with Dr. Robert Naiman, Director for the Center for Streamside Studies at the University of Washington. Dr. Naiman.

STATEMENT OF ROBERT J. NAIMAN, DIRECTOR, CENTER FOR STREAMSIDE STUDIES, UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON

Mr. NAIMAN. Thank you, Mr. Chairman.

Mr. STUDDS. You need to pull that microphone embarrassingly close.

Mr. NAIMAN. OK. Well, thank you, Mr. Chairman, for inviting me to appear before——

Mr. STUDDS. Even closer, believe it or not.

Mr. NAIMAN. How is that?

Mr. STUDDS. That is much better.

Mr. NAIMAN. Much better, OK. Well, thank you, Mr. Chairman, for inviting me to appear before you and the subcommittee to address issues concerning the management of watersheds and naturally spawning salmon populations in the Pacific Northwest.

Since time is short, I will get right to the point. Healthy watersheds are essential to the social, economic, and ecological well-being of all who inhabit the Pacific Northwest. The quality of the Pacific Northwest will be greatly diminished if we do not maintain the biotic integrity of our rivers and streams.

I would like to leave you with six points. First, that the ecological health of the Pacific Northwest river and riparian corridors is declining and declining rapidly. In Oregon and Washington alone, we have some 300,000 miles of streams and rivers. I would estimate, although there is no hard data on this, that probably around 75 to 80 percent of those stream and river miles are not in good condition.

Second, existing state and Federal land management practices will continue the incremental decline in watershed health and fish populations. Quite simply, the issue is too large and complex for any single institution to handle. Also, the management by system components rather than by a more holistic approach is contributing to this decline.

Third, effective management requires an ecosystem perspective to restore and maintain the ecological vitality of river systems. This perspective includes all organisms, not just salmon. Today we manage largely for stability from year to year, and we manage by component. Whereas the vitality of our systems tells us that we should manage for connectivity between components, and we should manage for variability over both time and space. Quite simply, our institutional philosophies are almost completely juxtaposed to this need. Fourth, not all parts of the watershed are created equal. From my point of view, the riparian systems are the heart of the watershed. They comprise only about 10 to 15 percent of our land mass, but if we look at the issues, probably 75 of our problems are associated with waters and the riparian areas.

Ecologically effective riparian management zones need to extend up the drainage network into nonfish-bearing streams as well as be expanded laterally downstream. This does not exclude some commodity extraction from the riparian areas as appropriate knowledge and technologies are developed. In fact, I think there are some very innovative things we could do in the future to have some commodity extraction from expanded riparian areas.

Fifth, there is an urgent need for a Pacific Northwest regional initiative or Center for Watershed Management which will transcend political boundaries, institutional structures, and philosophical approaches and disciplines. I propose a Pacific Northwest regional initiative for watershed restoration and management. The goal of the initiative would be the development of solutions to our regional watershed problems.

Now, what would this initiative do? It would conduct basic research into watershed science. It would establish a representative

array of watershed reference sites throughout the Pacific Northwest. It would establish watershed restoration projects as demonstration-sites for research and training. There would be the development of training programs for the future professional stewards of our resource base. There would be emphasis on watershed and regional consensus building. There would be technical and policy information transfer, and we would look toward the development of new approaches to commodity extraction such as developing new techniques for riparian silviculture.

My final point is that there are substantial economic and social benefits to managing rivers on a watershed basis and that these benefits accrue directly to the human populations and to the environment. Some of these would include, for example, the sustainable harvest of native fish populations over the long-term and the development of a sustainable riparian silviculture (one very much different than what we practice on our uplands at the moment).

There would be reduced litigation and downstream mitigation and cleanup. There would be the development of specialty tree crops for pulp and fiber such as genetic hybrids of Poplar. There would be the export, either nationally or globally, of watershed restoration and management expertise and techniques. The rest of the world needs this quite badly. There would be improvement to human health through recreation, and there would be a sustained ecological tourism industry.

If we do not act now, we will stand to lose much of what makes the Pacific Northwest unique. We will lose a significant aspect of our region's sustainable economy, and the salmon of the Pacific Northwest are the indicator of our watershed health. Thank you.

[The prepared statement of Mr. Naiman can be found at the end of the hearing.]

Mr. STUDDS. Thank you very much, sir. Next, Dr. James Karr, Director of the Institute for Environmental Studies also at the University of Washington. Dr. Karr.

STATEMENT OF JAMES KARR, DIRECTOR, INSTITUTE FOR ENVIRONMENTAL STUDIES, UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON

Mr. KARR. Thank you and good morning, Mr. Chairman. Thank you for inviting me to appear before this committee. Like rivers throughout North America, the rivers of the Northwest have been decimated in the last century. The degradation eclipses that of other resources such as wetlands that have received far more attention. An abundance of clean productive streams and riparian corridors has been reduced to vestiges. Failure to reverse the trend of aquatic degradation is unacceptable on legal, scientific, economic and ethical grounds.

A watershed can be considered healthy when its inherent potential is realized, its condition is stable, its capacity for self-repair when perturbed is preserved, and minimal external support for management is needed. By any of these criteria, the watersheds of the Northwest cannot be considered healthy. Over 97 percent of the naturally spawning salmon of the Columbia River have been

lost. How would we respond as a society if our agricultural productivity declined by over 90 percent?

All watersheds, however, cannot be preserved in pristine condition. The important thing is to buffer human influences on a significant proportion of those watershed areas to protect both the landscape and the waterscape.

Human actions damage salmon populations and the biological integrity more generally through their alteration of one or more of five factors: food sources for the aquatic food web, water quality, habitat structure, flow regime, and biotic interaction such as predation. Table two in my written testimony provides examples specific to the Pacific Northwest for each of these.

Because riparian areas serve as buffer zones between the terrestrial and aquatic components of regional landscapes, they are an important first line of defense. But the cumulative effect of activities in upland areas can overwhelm the effectiveness of riparian buffer strips. Thus, riparian areas should not be oversold as cures for depressed fish populations. In fact, we should be cautious of any quick fix solutions. Clean water and hatcheries have been the rallying cries of the past. Habitat, riparian corridor protection, barging of juvenile salmon, and bounties on squawfish are today's rallying cries. All are tools, but none will resolve the current resource crisis. Too frequently these solutions have developed to correct symptoms rather than problems. These examples of best management practices like the BMP's defined by soil conservationists must be combined to provide comprehensive location-specific best management systems.

Existing management regimes are not adequate to prevent further degradation of watersheds and fish runs. For example, the Clean Water Act has not been adequate because it has been implemented as if crystal clear distilled water flowing down concrete channels is the goal of the Act.

The Endangered Species Act provides an emergency room for treatment of critical patients [listed species] without providing a hospital or preventative care program to avoid listings. Simply put, existing government programs are too narrowly conceived and implemented, a problem that in the long run increases costs and exacerbates environmental damage. We need a broad societal policy that protects ecological integrity or health and avoids biotic impoverishment, a progressive erosion of earth's capacity to support living systems including human society.

Perhaps the most important barrier to this approach is the lack of societal literacy about the connections among resources and the dependence of human society on those resources. We act as if our ability to alter carrying capacity through technological innovation is unlimited. New policy goals and management objectives that integrate biological, social, cultural, and economic realities are needed.

The management techniques, indeed, have been available for years, but they have not been used in an integrative way. Comprehensive watershed restoration programs are needed. Special care, in my view, should be exercised to ensure that success is not measured in terms such as number of construction projects, permits issued, or hatchery fish released. Recently developed procedures

and approaches to watershed management and evaluation are available. It is time for us to begin to use them as a society.

The window of opportunity to reverse the decades-long trend in declining water resources and salmon populations is closing. The decline can only be reversed by substantive change in our actions and in the conceptual framework used to define those actions. Rivers are, in many ways, the lifeblood of human society. Their status is indicative of the health of the surrounding landscape in the same way that blood samples provide important insight about the health of humans. Our future depends on our ability to create positive long-lasting solutions.

An initiative that combines watershed planning perspectives with watershed restoration provides the central organizing principles that are fundamental to long-term success in these efforts. Thank you.

[The prepared statement of Mr. Karr can be found at the end of the hearing.]

Mr. STUDDS. Thank you very much, sir. Next, Mr. Patrick Higgins, Consulting Fisheries Biologist from—is it Arcata?

Mr. HIGGINS. Yes.

Mr. STUDDS. California. How do you like that? Welcome.

STATEMENT OF PATRICK HIGGINS, CONSULTING FISHERIES BIOLOGIST, ARCATA, CALIFORNIA

Mr. HIGGINS. Thank you, Chairman Studds and members of the panel. I am honored to be here. I am here on behalf of the Humboldt Chapter of the American Fisheries Society, and I helped to author a paper "Stocks at Risk in Northwestern California" that chronicles the decline toward extinction of Pacific salmonids in our area, and I will draw on that region for my specific case studies here in my testimony.

In my work for U.S. Fish and Wildlife Service and writing the Klamath River Restoration Plan which governs a 20 year, $40 million Federal effort to restore the fish. I characterized the river as severely ecologically stressed. I am afraid that characterization fits every major river system with the exception of the Smith River in northern California. The sediment in the Lower Klamath River is deposited to a depth of 20 to 30 feet. In the Eel River, it is 60 feet in depth. All the major holes are filled in. That means there is no cold water layers on the bottom for refuge areas for downstream migrating juveniles or for adult salmon as they come in early in fall. And it is a result of geologic instability and intensive logging and road building and subsequent failure of those roads primarily in flooding events.

The estuaries are filled in. These are critical habitats for juvenile chinook salmon, and there are also habitats for marine fish larvae, and the impact of estuaries being filled on the productivity of marine resources is completely unstudied.

Tributaries to these rivers which were once narrow and tree-lined cold, healthy ecosystems are now wide and open because they have harbored debris flows from upstream cumulative impacts. And with the warmer water temperatures that come into these tributaries, we get temperatures of 75 degrees in the Klamath in

the summer, 81 degrees in the South Fork of the Trinity. The Eel is over 80 degrees, and that makes a very, very good environment for exotic fishes that are introduced like green sunfish or the squawfish in the Eel, and those now, during prolonged droughts, threaten salmonids.

The Klamath, I must mention, flows through Upper Klamath Lake, and Upper Klamath Lake has not functioned as an ecosystem for 20 years. And the short-nosed sucker and the Lost River sucker are indicative of that problem, and unless the problems are reversed in Upper Klamath Lake, the Klamath watershed cannot be healed, and that is something I will revisit.

What is a healthy watershed? Healthy watersheds in our area stem largely from Roadless Areas on Forest Service lands or Wilderness Areas. And other than that, we don't have them.

Riparian zones—we have spoken of riparian zones on forest lands, and they are essential, and that is well-studied, but we also need to have the private agricultural lands in the lower areas of these rivers which were once the biological hot spots, the major producers of salmon. Those riparian zones need to be restored. Rivers like the Shasta now have very little vegetation on their banks. They reach 90 degrees in the summer. Instead of producing 80,000 fish as it did in the '30's or 30,000 fish as it did in the '60's, it has fewer than 500. And there are benefits to restoring riparian zones for agricultural interests as well as the help of aquatic ecosystems.

Past management has failed to protect watersheds and fish, and the U.S. Forest Service is showing some very, very encouraging signs with their packfish program. It needs to be followed through and implemented, but we need to preserve refuge areas. And I will revisit that also as part of strategies, and we need also to rebuild the Forest Service staff. They need capable staff in fisheries and watershed. That has to be expanded, and they are overstaffed in timber, and there has to be some attrition.

I would like to contrast the U.S. Forest Service actions on timber harvests and private timber. Grouse Creek on the South Fork of the Trinity has been locked up because of cumulative effects concerns on Forest Service land. The California Department of Forestry has never turned down a timber harvest permit in that watershed.

Steep, unstable inner-gorge areas where everything goes into the drink if you lose your soil, they are locked up on Six Rivers National Forest. They are clear-cut on private lands. PAC fish is coming along in the Forest Service. It is encouraging. Denial reins supreme for the California Department of Forestry. We are losing coho salmon, and yet they won't even acknowledge it as a sensitive species or designate watersheds as sensitive where we have this species. And it could be listed as threatened currently in California.

Best management practices under the Clean Water Act have never been certified in California and the whole change of command from EPA to the State Water Board to CDF, California Department of Forestry. It is not working. EPA, when you reauthorize the Clean Water Act, needs more direct authority in best management practices implementation in California.

We also need fundamental reform of water law in California.

I support a watershed approach to restoring rivers, and I think Bob Doppelt will detail this because I support the Pacific Rivers Council strategy. It is science based, and it is very similar in the strategy the Klamath River Plan, which I helped to author. But we need refuge preserves. Overcutting on private lands has been catastrophic. We have fragmented forests on public lands from imprudent past activity. If we do not preserve forest preserve areas to save the fish as well as the spotted owl, we won't have the gene resources to restore these fish.

I believe on private land we have a major challenge. We have got tens of thousands of miles of logging roads in northwestern California, and they need to be put to bed. And the Soil Conservation Service should play a key role in the water conservation and the restoring of the riparian zones on private land as well as in upland restoration.

And you are concerned with the debt right now and what portion of that we will leave to future generations. I would suggest that you examine Pacific salmon, and if we leave a deficit both economically and culturally to future generations, it is in perpetuity. And I think that the public supports the restoration of these fish, and I think the time is right for leadership.

[The prepared statement of Mr. Higgins can be found at the end of the hearing.]

Mr. STUDDS. Thank you very much, sir. Finally, Mr. Bob Doppelt, Executive Director of the Pacific Rivers Council from Eugene, Oregon. Mr. Doppelt.

STATEMENT OF BOB DOPPELT, EXECUTIVE DIRECTOR, PACIFIC RIVERS COUNCIL, EUGENE, OREGON

Mr. DOPPELT. Thank you, Mr. Chairman. The degradation of the Pacific Northwest and, indeed, America's river systems and the extinction of salmon and other forms of riverine and riparian biodiversity have, as we have heard today, reached alarming levels. Fisheries, health water quality, and quantity produced by watershed ecosystems and entire aquatic food chains are at risk throughout our region and, indeed, nationwide.

For the past two years, our organization has been involved with a major project to assess the capability of the Pacific Northwest, policies and strategies to restore watersheds and riverine ecosystems, and, indeed, we have assessed the nation's river policies capabilities. We have produced a report that details our assessments, what we found, and what I will talk about today is basically the regions and nation's watersheds restoration strategies and policies have failed and are inadequate and that we believe entirely new strategies and entirely new policies are needed to both quickly stave off the impending collapse of many riverine systems and to prevent widespread wholesale biological extinctions.

I want to make seven key points in my testimony if I may. First, especially in the Pacific Northwest, it is important to understand that the endangered salmon are just symbolic of a range of river ecosystem and biodiversity losses occurring across the region. The crisis is not just with salmon but within entire river ecosystems and the entire range of riverine and riparian biodiversity.

For example, in addition to the AFS list of 214 endangered salmon, at least 132 species of riparian-associated animals including three birds, four mammals, 12 amphibians, et cetera, and over 700 of 1,100 native fishes which includes estuarial and resident fishes were found to be at risk of extinction on the west side of the Pacific Northwest within the range of the spotted owl. This is a regional ecosystem crisis, not just a salmon crisis.

Second, although the media has focused primarily to this point on the dams in the Columbia as the major problem, these types of broad-ranging problems cannot be blamed exclusively on dams, nor on overfishing, nor on anything else. For example, 175 of the 214 at-risk salmon populations in the region spawn outside of the Columbia River basin, many in streams with no dams. Many are not commercially harvested by commercial fisheries, and the vast majority of riparian and resident fish species at risk such as Bull Trout indicate that something else is going on. And as we have discussed today, what is going on is habitat loss and river ecosystem disfunction.

Third, I support what Dr. Karr just said and that is there is no quick solution to these problems. Fourth, however, I do believe, we do believe, and the scientists we have been working with believe that there are some immediate steps in the Pacific Northwest that can and, in fact, must be taken to stop the hemorrhaging of the systems and to anchor watershed restoration recovery strategies.

Numerous scientific studies have confirmed that only a few pockets of healthy habitats remain throughout the region. The vast majority of these areas, as Pat just said, are found in the steep, unroaded, primarily old growth areas on Federal lands regionwide. In fact, the salmon evolved in an old growth environment, that the old growth provides the best habitat for salmon, the most complex and diverse habitat. These key watersheds act as the physical refuges for fisheries and biodiversity and is a source of species to recolonize degraded areas once restored. They are also the key to maintaining the existing levels of health for most of our river systems and, hence, as I have said, are the anchors for watershed restoration programs.

We believe that it is imperative to immediately identify and protect the remaining healthy habitats, the remaining key watershed refuges at the watershed level to provide a basis to maintain and restore the region's river systems and biodiversity. We also believe that riparian protection and flood plain protections must be implemented across the board on Federal lands throughout the region. However, I want to reiterate that riparian protection alone is not going to be sufficient. We need to establish the key refuges.

Fifth, once protected, the key refuges must be secured, and I will use that term as different than protected. Even the best remaining habitat for salmonids and the best watershed refuges are at risk from primarily road systems that are already build into these watersheds. We have not had a major rain event in the Pacific Northwest in about 10 years except north of Seattle in the Skagit area. The next major rain event, in fact, could create catastrophic debris flows from the road systems and essentially degrade or, in fact, wipe out many of the best remaining salmon habitat areas in the

region. So we must immediately institute a storm-proofing strategy to secure these best remaining areas.

Sixth, following the protection of these areas, and we emphasize again that that is a key point, that we must first protect and secure these areas before we institute watershed level restoration strategies. Following that step, we believe that whole watershed level restoration strategies can be implemented that include the private landowners and others. In fact, we think that a whole new strategy is needed to implement those kind of strategies.

That strategy would include focusing on the best remaining habitat areas within the system, to identify and protect the best remaining biological hot spots found within the whole system and to wrap restoration around expanding and linking the best remaining areas rather than focusing on the most degraded areas. All of those steps would require new Federal policies. Finally, we believe, in summary, that a new strategic Federal watershed restoration initiative is needed throughout the Pacific Northwest that, again, begins on Federal lands and then moves down to the private lands. Thank you, Mr. Chairman.

[The prepared statement of Mr. Doppelt can be found at the end of the hearing.]

Mr. STUDDS. Thank you very much for your very thoughtful testimony. Did you say there hadn't been a major rain event in Seattle?

Mr. DOPPELT. I think it is raining today in Seattle. No major 100-year rain event has occurred throughout the region except north of Seattle.

Mr. STUDDS. I see. I sort of thought it was a major rain event. I want to thank you for an exceptionally thoughtful testimony. As I indicated at the outset, I am going to have to leave very shortly, and please do not interpret that as a lack of interest or concern on my part. I was depressed with life in general before I came this morning, and you have deepened that. So, obviously, your testimony has been very effective. It is, like so many things, enormously complex and obviously has no single easy solution.

I think you have all suggested that. You have all suggested that in its complexity we are really dealing with cumulative effects, and, therefore, the response, whatever it is, has to be comprehensive in nature. And I would imagine we would have to find some way to work on private—obviously, you have mentioned that—as well as public lands, which is always difficult, especially here.

At the very end, Mr. Doppelt, you began to give some specifics. I assume we are not going to develop a comprehensive solution to this problem before this hearing is over, but if each of you could have us do one or two things at the Federal level which would constitute the most productive and creative start at a solution, what kind of things would they be? I don't suppose I should ask you to imagine yourself as king for a day or whatever the appropriate image is, but if you had a magic wand at the Federal level and you could implement one or two either changes in existing law or enactments of additional law, what would you have us do right out of the box, first off? Anybody? Mr. Doppelt.

Mr. DOPPELT. Mr. Chairman, it is a good question. I have about 10 things on my list, but I will only talk about one or two. I think, as I have said, that the first step is to align the policies among the

Federal land management agencies, require that they get coordinated and aligned together, and require that they identify and protect the key remaining habitats on Federal lands and to implement landscapewide riparian protections. That would be step one. We need a whole new Federal land riverine management act in this country that would apply to Federal lands across the country to protect watersheds and riverine systems, and I think we can begin in the Northwest by setting a precedent for that.

Step two, I think, would be that we need leadership from Congress to pull together all the different agencies involved with riverine systems across the Northwest and, indeed, nationwide. I think a strategic Federal watershed restoration initiative, in fact, is needed across the country, not just in the Pacific Northwest. This is going to require, I think, one department to coordinate and align the policies and to get everyone marching down the same direction. I think those would be the two things I would focus on.

Mr. STUDDS. That is an easy start. The good news, obviously, is that the new Secretary of Interior is thinking along those lines. I suspect he would know which department it ought to be to coordinate that, but as you probably know, he is initiating an effort to develop a biological survey patterned after the geological survey. We have to be introducing legislation very soon which takes very much the approach you were talking about, toward whole systems, but there are a myriad of Federal agencies, as you well know, who each have a little piece of this. Anyone else want to respond to that question?

Mr. NAIMAN. I would also like to suggest something along the same lines. You know, it has come up around this table as well as in other hearings and other activities that we have been involved in, but it is the real need for a regional initiative, that the issues are certainly too large and complex for any single agency or any single group. These issues transcend political boundaries wherever we go.

And there is another part of this. If we do come up with a regional initiative, there are a couple parts I think are especially important—one is that you should probably initially keep it small to bring together the best of the best people in a think tank to provide a comprehensive strategic planning. If we try to include everybody at once, it is going to a problem right from the outset.

The second part is equally important—that is, as we move into the future, we have need to understand how to integrate environmental and human issues. We simply do not know how to do this despite what agencies and other groups say. We simply do not know how to reach levels of sustainability whereby we take care of the people in our communities and at the same time provide a healthy environment for the long-term. And whatever this initiative is, it has to integrate both of those elements, and it has to integrate them at a very fundamental level.

And if there was anything that I would do first before attempting to restore the streams and rivers, it would be to have a relatively small and select group of people with vision and innovation to provide a comprehensive evaluation of the situation.

Mr. STUDDS. Thank you. Dr. Karr? Dr. Higgins, go ahead.

Mr. HIGGINS. I believe that these fish provide us a symbol where we can win widespread public cooperation, but if you take decisive action, taking a watershed restoration approach, it will create jobs in the Pacific Northwest for displaced timber workers. The same people who built those roads could put them to bed, but we need ancient forest legislation though that locks up the habitat that preserves the owl and the fish. And also we need a stronger Clean Water Act. We just are missing the boat. There is a wholesale abrogation of the Clean Water Act as it applies to nonpoint source pollution on private timberlands, and it has got to be remedied, and I think it has got to come from the top because at the local level things seem to slip through the cracks.

Mr. STUDDS. Dr. Karr.

Mr. KARR. An aside. As long as we implement the Clean Water Act to get the chemical contaminants out of it and leave everything else alone, we will not have good quality water resources. In a more general sense, what we really need is a substantive change in the kinds of actions we take and the conceptual framework as a society that is appropriate to the long-term need. We buy new cars. If we don't like our house, we sell it. If we don't like our job, we get a new job. We don't have another place to go and live. That is the only thing that we can't change, and those of us who live in the Pacific Northwest have to focus on the issue that we will live there as a society 50 years from now and 100 years from now. We must change the way we treat not water but the whole landscape; the conceptual framework that we use to plan must be altered.

Mr. STUDDS. Thank you very much. The gentleman from Maryland.

Mr. GILCHREST. Thank you, Mr. Chairman. I am going to ask just one question with a lot of different answers, but before I ask the question, I want you to know that I support your initiative. Watershed management and a comprehensive national program is a positive thing to do for future generations, and we should look at this problem the way you have suggested we look at the debt. We want future generations to live in a productive, clean environment.

Being from the Chesapeake Bay, I recognize this. Only one percent of the potential oysters are left. 99 percent of them are gone in the last 100 years. Clams have just about disappeared. The crab harvest is being diminished. When we managed something we call rockfish or striped bass, it came back, but that was a regional approach which was very successful

You mentioned, I think, Mr. Higgins, or somebody mentioned something about the Clean Water Act and the purpose of the Federal Government creating laws to protect habitat not being adhered to by the State of California or by the Forest Service. I must conclude on that that there is a healthy resistance to some of your proposals by a lot of people, maybe agriculture, maybe timber, but there is resistance out there to change to clear-cutting, to a whole host of other things including the spotted owl.

My question is you made reference to agricultural land being—I don't think you used the term buffer zone, but we use that over here—taken out of production for the protection of protecting the riparian zone for watershed management. You also made reference

to nonpoint source pollution which directly impacts private property rights in a whole host of different areas.

Focusing just for a minute on agriculture, is there a specific plan to compensate the farmer for taking out of production some of his agricultural land for the purpose of preserving the rivers or the watershed? Now, I understand we have the swampbuster program, and there is a whole host of other Federal programs that if farmers comply with them, they can be a part of Federal insurance and crop insurance and set-aside programs and things of that nature. Do you see the agricultural industry and the timber industry to a certain extent, especially on private lands, being successful in their resistance to a nationwide watershed management program perhaps by the Department of the Interior?

Mr. HIGGINS. First of all, no man has got the right to mass waste his soil capital even if he owns fee title, and if we would vary from that principle, civilization has fallen on that one, and that is what is happening in the Pacific Northwest. If we keep doing that for 100 years or 500 years, we won't grow trees because we won't have the dirt.

Insofar as it goes on private land, I believe that there are benefits for the farmer and that it is stewardship that is lacking here, they have a short-term perspective on private land riparian zones—if you degrade your riparian and then you get a flood and you don't have anything armoring your banks, it eats your fields. You lose tremendous amounts of valuable agricultural land. So it is in the farmer's best interest to restore those riparian zones for his own interest to maintain a soil capital.

Secondly, if you remove your riparian zones in many areas, the stream downcuts. That drops the water table, and then you reduce the productivity of the lands adjacent to that stream, and oftentimes when you restore those riparian zones, you can put in drop structures and restore that water table, and the areas away from the riparian zone become more productive agricultural lands, and they require less irrigation water. So it is in the farmer's best interest, I would argue, in almost every case to be a better steward of those riparian zones and that in many cases there is an offsetting beneficial value to restoring those riparian zones for the productivity of his lands outside the riparian that offset the losses that they would accrue in terms of what they lose for grazing in those riparian areas.

And, you know, everybody has got a public trust responsibility. If you denude your riparian zones and then that soil washes into the stream and collectively the river becomes 90 degrees and also the cows' direct access to these streams when you have warm water temperatures, the increased biological oxygen demand from the waste products, it befouls the river. The Shasta River's got 2.4 parts per million dissolved oxygen, and it is lethal to fish and so there is a collective responsibility. One guy's cows might not do it, but collectively all their cows have befouled the river to the point where no one swims in it, no one would drink it, and the fish are dying.

And so we have got to work together, and so everybody has got to give a little bit, the same as the budget. And if everybody has got to be compensated for every increment that they participate,

then we are all going to go broke, and we are never going to get there.

Mr. KARR. I would just comment, if I may, on that as well. Many proposals have been made over the last 10 or 15 years dealing with issues like classified channel and cross compliance, a whole series of land-planning programs within the agricultural community that provide very important mechanisms to both protect the interests of agricultural productivity over the short-term and the long-term and the other environmental benefits that will come from these activities.

Mr. DOPPELT. If I may add one thing also, I think that I fully agree with what Pat just said. I would also add that for the most part, farmers and ranchers and local landowners within a river system or watershed don't really know how their lands connect with the rest of the system and how they may be impacting folks downstream or upstream of them. I think they need to be brought into a process to understand how the whole system works, where their lands are, what their impacts may be, who is impacting their lands from above them upstream. There are a number of strategies for doing that. We propose that a national watershed registry system be put in place which brings together all the landowners within a watershed to develop an assessment of the system, to identify what the problems are, to begin to look at restoration alternatives.

From that, I think quite often people find that restoration is possible, and it is not a great financial loss. In fact, it is financially very helpful, but they first have to be brought into understand how the system works and their role in it.

Mr. NAIMAN. I would agree also, and a point I would add is that the Northwest is going through at this stage is what the rest of the developed world has already gone through. If we look to other developed countries such as Japan or throughout Europe, they went through these same sorts of issues (with probably not as much scrutiny) anywhere from decade to centuries ago.

And if we look at what is going on in many of those countries, especially in Europe, they have major restoration projects on the Danube, the Rhine, the Garonne, and other rivers. They realize the value that the natural ecological services that those systems provided for them. They spent 100's of years ago, probably the equivalent of millions of dollars to straighten those same rivers and isolate them from the riparian floodplains. Today they are paying hundreds of millions, if not billions of dollars to reconnect those rivers to their floodplains to get back the same ecological services. In the Northwest we are very fortunate because we are not as far along that continuum of degradation. We still have the possibility to turn this around and have those ecological services work for us essentially for free.

Now, another aspect is what is going on in agriculture, grazing lands, and forests. When we look around the world, we see plenty of demonstrations of how good land management benefits either the rancher, the farmer or the person working in the forest. In eastern Oregon, for example, the work on rotational grazing on riparian lands, we have streams that did not flow permanently for the last 90 years flowing year round now. The ranchers now have

more cattle on those lands than they ever had before because the cattle are moving out of the riparian areas and using the uplands.

We can look to Europe and what they have done. Europe has heavy nutrient subsidies on their agricultural lands (Maryland also provides an excellent example of this too). Europeans have put specialty crops in riparian areas such as cottonwood or other forms of fast growing trees. The nutrients leaching off the lands act as a fertilizer subsidy for the trees in the riparian forest, and those are harvested on a regular schedule providing a commodity to the farmers for maintaining those systems. And water quality in the streams and rivers in those areas is extremely good. It is not perfect, but it is extremely good. There are many things that we can do like that.

And in the Northwest, if we would open our eyes and look around the world, there are plenty of innovative examples to draw upon and bring to bear on our own problems.

Mr. GILCHREST. If I may make one last comment, Mr. Chairman. If you are not familiar, and you may already be, with the Chesapeake Bay program, which is a regional approach to cleaning up the Chesapeake Bay, we are coming along pretty successfully, and the State of Maryland has a law called the critical areas legislation which protects the land within 1,000 feet of any tributary to the Bay and the Bay itself, and nothing can be developed within 100 feet of a tributary or a bay, and there is constant tension there, but it is growing and it is pretty successful. Thank you.

Mr. STUDDS. I thank the gentleman. I, at this point, am going to turn the hearing over. Let me just say that my depression has been mitigated by two things. First of all, the fact that the scientists of the Pacific Northwest are clearly also poets and philosophers which always helps and, second, by the extraordinary caliber of the delegation on this committee from that region. If there is any hope at all in terms of the vision and initiative that you folks are seeking, it lies in people of the caliber of the three members from your region of the country who sit before you at the moment. They are magnificent, and we are very lucky to have them on the committee. And I now turn to what we up here in our funny talk call the distinguished gentlewoman from Washington to take over.

Mrs. UNSOELD. [presiding] Thank you, Mr. Chairman. And I am overwhelmed with frustration because for decades we have failed to use the kind of expertise in adequately developing—your expertise in developing management plans—and now I have five minutes to try to extract that all from you. I am concerned having been part of the effort to familiarize the public and my colleagues and the news media with the term ecosystem approach. I am suddenly alarmed that I see the Forest Service creating an ecosystem approach, BLM doing one, somebody else doing another, and very quickly now because there are other things I want to get to, can you give substance to what we mean by an ecosystem approach or perhaps what it isn't so that we have for the record sort of a landmark?

Mr. KARR. I will take a shot at that. The fundamentally important issue is to protect life support systems—the biology which sustain human society. Ecosystem is a word that is used in several different ways; it is ill defined. I would prefer to use the phrase an

ecological approach. The fundamental underpinning of that is to protect the long-term interests of society in terms of the biological integrity of the resources that we depend upon. That requires us not to look at the human actions but to look at the condition of biological systems as the fundamental way to determine whether they are healthy or not. Too frequently we count permits, we count contaminants without looking at biology. And if we look at biology carefully, we can protect ecological systems.

Mrs. UNSOELD. An excellent description but you have got to have three or four words that are going to substitute for ecosystem approach that is going to get the concept across. Anyone else want to throw—or what it isn't? And what I am fishing for is incorporating the term integration, I believe, somehow into this.

Mr. DOPPELT. I will take a shot at it, but I am not sure I will use that term——

Mrs. UNSOELD. OK.

Mr. DOPPELT [continuing]. if that is OK. From a riverine perspective, I can't speak about ecosystem management on a broader perspective, but I think from a riverine system perspective it means integrating the concept of conservation biology which begins with the belief that there is not a whole lot left and it is fragmented. Where do we begin within a fragmented system and watershed dynamics—integrating those two within the context of full watershed level management that really comes down to from our point of view to identifying and protecting the remaining biotic refuges that may exist in the Northwest salmon refuges as we have talked about, the remaining riparian areas and floodplains and what we call the biological hot spots found throughout the system to begin with that because we have to acknowledge that the systems are fragmented.

There aren't a whole lot of real long healthy ecosystems that exist so how do we manage fragmented systems? We have to identify the healthy patches that still remain, hang onto them, begin to link them and expand those. That is how I would define it.

Mrs. UNSOELD. The reason I am trying to pursue this is that if we protect or lock up watersheds, besides recognizing the technical, the needs for this approach, we have to politically be able to accomplish it. And, Mr. Higgins, I am afraid I would have to take exception to your statement that it is in the farmer's best interest and, therefore, why wouldn't the farmer just go ahead and do this. How do we get them to do it? It is almost impossible when we, the Feds, own the land to get that change to take place. How do we do it in the bigger picture and particularly when it is private land?

Mr. HIGGINS. Well, you kind of changed the question there. I guess it is a new question, but right now in the Shasta River I think it makes a very interesting case study because with fewer than 500 chinook salmon returning to that river and a baseline that is continuous back to the 1930's, we have got a classic textbook threatened or endangered species. So there is another specter that all of a sudden we get the National Marine and Fishery Service or U.S. Fish and Wildlife Service telling them how to graze their cows instead of them coming up with a grassroots holistic approach in their local area that is most effective and cost effective. And so we have to change. I mean, we are there. I think that will drive people

to the table. The way to look at it is all of these fish co-evolved so if you keep a healthy river system in the Shasta, for instance, the chinook come in, and then the coho salmon come in, and then the steelhead come in, and they all take turns using spawning environments. And then the coho use little pools where there are stumps, and then the chinook go out of the system generally, and the steelhead stay for two or three years. There is niche partitioning so if we maintain a healthy ecosystem, we have got sports fish, we have got commercial fish, and we have also got the water quality that these things are indicators of.

And so I think that is what we have to stress to people is that we need the salamanders at the headwaters, and if those things are missing, that means we probably had things go through there, big debris flows, that then had impact on the fish that were more insidious. It is like the whole thing functions as a whole, and as you fragment it, it starts to break down, and unless we rebuild it, it is going to collapse. And it is pretty simple.

Mrs. UNSOELD. My time on this round is expired. Bob, did you have something you wanted to just quickly add to that?

Mr. NAIMAN. Well, to come back to your first question on what is ecosystem management, I put forward that it is an integrated social and ecological perspective to watershed management. I stress the social part because we cannot have ecosystem management without including the human component. There has to be a balance. It is the people that are the future stewards of our land. This maybe addresses your second question. The most effective ways that I have seen anywhere are the development of demonstration-sites to show people, whether they are farmers or whether they are cattlemen or timber owners, that it can be done better. That you can have ecological or environmental vitality but at the same time have a good social and economic fabric in your community.

Mrs. UNSOELD. And I believe that the Chairman when he is saying what would be the one thing you would do or the one or two things, I would ask that as you go back home or later today or whenever you think about this that perhaps you will have additional suggestions to give us because although you can say and we can say change has to take place, for somebody who is only today looking at the bottom line, tomorrow will never come. And how we provide those pilot programs or something that illustrates so they can see, "Oh, it can benefit me today as well as into the future," we have got to bring that into the solution. And I apologize to the rest of the committee. I have taken more than my time.

Mr. GILCHREST. Would the gentlelady yield just for a second?

Mrs. UNSOELD. Yes. My time is gone.

Mr. GILCHREST. Thank you. I live in the First District of Maryland, eastern shore, very rural, mostly agricultural, and we have not had a difficult time with wetlands or other ideas of that sort to protect the rivers and the Bay. We have a videotape of how farmers can live with wetlands and improve the farming techniques much the same way you were talking about the area around the Shasta River so what we have done and will continue to do is send to every extension office in our district, which the farmers use constantly, a couple of those tapes which can be used to begin—it is a small step—but to begin the process of spreading that education.

Mrs. UNSOELD. Very good. Thank you. I will now yield to the gentlewoman from Oregon, Ms. Furse.

Ms. FURSE. I would just like to ask, Madam Chair, if we could have unanimous consent to leave the record open at the end of this hearing because I do have some questions.

Mrs. UNSOELD. It always is for two weeks.

Ms. FURSE. Right. Thank you.

Mrs. UNSOELD. All right. Then the gentleman from northern California, Mr. Hamburg.

Mr. HAMBURG. Thank you, Madam Chairwoman. I was really moved by this testimony, and part of it is the very difficult economic situation in my district which I mentioned in my opening statement, but even more than that, it is just kind of a gut concern I have and a concern that I know is evident in this room that we are destroying our biological heritage, and we don't get another shot at this. I am very glad to hear Dr. Naiman talk about countries in Europe which have gone to the brink and have seen—it reminds me of the Pogo quote about if we don't change direction, we are going to end up where we are headed. And I think, indeed, that is our situation, and we really have no choice.

And, you know, as passionately as our new President has talked about our total need to change in many ways that we do business in our society, there is surely no area where we need to change more than in terms of this whole issue of watershed restoration. And also our new President has talked a lot about the need to invest in infrastructure, and I am all for good roads and bridges and all these other kind of public works projects, but perhaps this is the most fundamental infrastructure project because this is the infrastructure of our lives. And if we don't repair this infrastructure, you know, all the roads and bridges are not going to, you know, put Humpty back together again. So I was very moved by the testimony. I thank you very much.

I want to just ask Dr. Karr if you would expand a little bit on your statement about the need for or the lack of societal literacy. How do we teach our children, and how do we teach society? And I think this is something that Congresswoman Unsoeld was trying to get at. What are the ways that we can get this idea across broadly enough so we can build the kind of political will and momentum that we need to make this happen? Because, you know, all the hearings in the world like this are not going to do it. We need to be able to make this an issue that has national prominence and will build a political momentum for it.

Mr. KARR. As a society we have to recognize our dependence on earth's life support systems. We can't infinitely substitute increasingly complex and expensive technologies to replace the degradation in those life support systems. If I were to recommend one thing for you to read, I would recommend that you read a book by David Orr entitled "Ecological Literacy." It is a wonderful explanation of the lack in our educational system of making people understand those dependencies.

Mr. HAMBURG. Anyone else want to comment on societal literacy around these issues?

Mr. DOPPELT. Yes. I will take a shot at it in a different way, that I think that in part, given where we are today, we have to start

with Federal leadership on these issues, and that means congressional leadership too. In fact, the message to the Pacific Northwest for the past 30 years from Congress has not been to protect and restore and take care of these things, but, in fact, it has been at best a mixed message and at worse a message, in fact, to go ahead and degrade.

So we can't just begin out in the schools, given that there is not a whole lot of healthy areas remaining, and we need to move quickly. We need Congress to make a very clear statement through very clear policies about what should be done, and I think the best way Congress can act is through the Federal lands first because that is where you have the most direct contact, and to set a new course.

The agencies, I think, are going to begin to do better under the new Administration, but they probably are going to need even more encouragement and direction from Congress. I strongly encourage Congress to legislate new watershed protection and restoration policies both on Federal lands and then to legislate a new strategy to bring together landowners and others within full watersheds to create watershed level restoration strategies. This will not happen without the leadership of Congress.

Mr. HIGGINS. I believe that is the case. I think that the reason we have such fractiousness right now and such a strong reaction from private landholders is that we have a lack of leadership. They have just kind of thrown it out and said, "OK. You guys grapple with it." I don't think that is a sound approach. And I think that through taking clear, incisive and decisive action, if you look at the Roper polls and the PAC fish report from the Forest Service, there is public support for maintaining biodiversity. It is the local interest groups, whether it is the people around Upper Klamath Lake or whether it is the people on the Shasta River, they have a resistant subculture that speaks largely to each other. And by forcing some change from top down, you put this on the table.

And the wider public supports it even though your local constituencies oppose it. I am a grassroots up guy though, and I will be participating on the Eel River in a Forest, Farms, and Fish—We Need Them All Conference and explaining to the people in the Eel River that they are losing salmon and steelhead. That the option of going to fish after working at the mill or farming in the fields to catch a 40 or 50-pound salmon as a meal for two weeks for your family is not going to be part of the fabric. And nobody wants to lose the fish, nobody wants to lose tremendous amounts of soil capital. So if we would switch these arguments and put this on the table, we have got ourselves a very powerful political issue here.

Mr. HAMBURG. Thanks very much. I do have some other questions that I will submit.

Mrs. UNSOELD. Go ahead.

Mr. HAMBURG. Well, how much time will you give me?

Mrs. UNSOELD. I will give you another minute or two before we call the other panel.

Mr. HAMBURG. OK. Well, Patrick, just to get to something specific that you mentioned regarding progressive policies in terms of logging practices in the Six Rivers National Forest, and I wondered if you could just elaborate for a minute on what that means or what that meant in Six Rivers and what you think that means in

terms of regulation of logging practices, and whether there should be—this is too long for a minute—some Federal statutory framework that should be implemented to more or less force these kinds of changes to take place?

Mr. HIGGINS. Six Rivers is a model for anadromous fish preservation and for restoration programs as well. The recognition of these issues has come about—well, at least in part because we have got a very strong local environmental community that has forced these issues on them. But then they have taken an interdisciplinary approach with a team of scientists from various disciplines of hydrology, geology, watershed management, fisheries, and they have resolved these issues. They not only found out in science what we need to do, but they put it into management. And that is the problem, that most of the stuff in the think tank never gets into the nuts and bolts of how we work.

And how to do that on private land, I mean, I have been working with CDF till the cows come home, and they don't even want to deal with these issues. So I think until there is some Federal action that tightens—there is too much slip between the Clean Water Act and what goes on in private forest lands. I am not exactly sure of the statutory language or approach that should be implemented to remedy that problem. The models—logging in California in Santa Cruz, they log on some of the most unstable terrain in the entire region. It is decomposed granitic sands and uplifted marine stuff, and they have logged with great productivity, and they don't have any problems with floods. And they say, "Boy, you can't do anything but clear cut to make it cost effective."

I have seen trees go from twelve inches around that are 135 years old out to two feet in diameter in 10 years when you remove the overstory around them due to competitive release. They don't disrupt the forest flora. If you tried to replant all the forest flora and restore its biodiversity, it would cost you hundreds of thousands per site, and they do their logging so that it doesn't disturb the flora. The fauna, the fishes, and the biological diversity of amphibian species and spotted owls and all a host of wildlife are not disrupted. So we have models even on private land in Santa Cruz because the county got tough and made CDF play ball.

So we have got the models on Forest Service land where we are and Santa Cruz down a little further, which is very similar to a lot of lands that are being logged on private so we know where we need to go, and it is just a question of institutional denial. And the industry is running private logging in California. They make their own rules, they couch them in terms that are more obscure than the riddle of the sphinx, and it is primarily to obscure and to make enough wiggle room so that they can do what they want. And so, how we are going to do that in terms of revising the Clean Water Act, I will give some thought to it.

Mrs. UNSOELD. Go ahead.

Mr. KARR. Thank you. I would just like to make one comment about history. I grew up in the Midwest where over the last 100 years we have seen major efforts to improve the economic value and productivity potential of our agricultural lands. And what we have lost in that hellbent-for-leather approach to increasing productivity is the social fabric of midwestern communities. The agri-

cultural communities don't exist the way they used to because of that narrow focus and goal. And I think it is important for us now in the Northwest to try to do things that will protect that social fabric, and the way to do that is the natural resource base needs to be protected.

Mrs. UNSOELD. Thank you. I probably should have asked my earlier question in a way that you could only give a yes or no answer. I am going to take one more run at it. Is it possible to have an ecosystem approach without interagency cooperation?

Mr. DOPPELT. No.

Mr. KARR. No.

Mrs. UNSOELD. OK. Because that is what I was fishing for—is that the Federal, the state, all of the agencies are really going to have to work together. And you want to do a P.S. on that?

Mr. DOPPELT. Yes, if I may. We have done extensive study on the agency cooperation issue, and I just want to suggest that we believe that just cooperation may never be possible when agencies have different missions and goals legislatively established, that, in fact, cooperation is not necessarily what we want. It is policy and mission alignment within a watershed, and it is very different, that they are all using the same resource standards, the same standards and rules for riparian protections, et cetera, that aligning the different policies and missions is really what is needed, not cooperation although that is helpful.

Mrs. UNSOELD. A good new term. And if we don't align those policies and have an integration among the Federal agencies—if we can't do that, how in the world are we going to get the private landowners to be involved? And one other yes or no question. Is there a mechanism in place now to coordinate the regional efforts to protect riparian areas?

Mr. NAIMAN. No.

Mr. KARR. No.

Mrs. UNSOELD. I would like to thank this panel, and what I would like to lay out to you also, you have described eloquently the problems and some of the approach—the technical things that need to be changed in order to approach these problems. If you also have ideas on the "how" we do it that should be integrated into legislation so that there are those visible pilot programs or whatever so people want to change because getting the human species to change its habits is sometimes more difficult than the technical analysis of the problem and the theoretical solution. But I thank you very, very much, and I hope you will stay in close contact with the committee. The second panel? I see at this time we have an integrated panel. I will call on Dr. Hershberger first.

STATEMENT OF WILLIAM HERSHBERGER, SCHOOL OF FISHERIES, UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON

Mr. HERSHBERGER. Thank you. I want to thank you for giving me the opportunity to testify before this subcommittee. It is a subject that I am personally and professionally immersed in in the Pacific Northwest, and it is also an important resource as far as the economic component of the Pacific Northwest and an important indicator of our way of life.

Restoration of naturally spawning salmon populations is an extremely important aim and goal for the conservation of the Pacific salmon resource. It not only is our gene bank to maintain genetic and biological diversity and variability, it also is a barometer of the health of the aquatic environment in our part of the country and throughout the country, and pragmatically, which we at times have a tendency to forget, it is the least expensive way to produce Pacific salmon, that relying on the natural environment is much less expensive than providing all our technology to do the same thing.

Several things need to be done to this in way of preface to my talk about the use of hatcheries. The first thing that we need to do, as has been mentioned very eloquently by the previous panel, is we need to improve damaged habitat and maintain it. Without that, we will not restore naturally spawning populations.

Secondly, I think we need to initiate a coordinated rational management of harvest of the resources so that we are not constantly throwing natural populations into a tailspin. And, finally, where hatcheries play a role in this, I think we need to restore salmon populations into the usable habitats we have maintained, and this is where the hatcheries can play a major role and, in fact, I think should play a major role.

In defining the best possible role of hatcheries for restoration of natural salmon populations, I think it is a matter that we need to simply restore the salmon populations rather than finding a best possible role. Best possible roles for hatcheries have historically gotten us into difficulties. The first best possible role to hatcheries, as we started out, was, in fact, to restore natural salmon populations—historically, two major areas which I think need attention. Initially, they were used to spread species across the country with a lack of scientific knowledge to benefit this, and, secondly, they were used as a replacement for naturally spawning stocks which has also gotten us into some difficulties as far as the use of hatcheries.

The key word, I think, as far as the use of hatchery facilities in the use of restoring natural populations is versatility. The technology is there to provide the resources in pretty much any form or any situation we need to, but we need to employ the versatility to address the problem at hand. Now, to address the technology just for a moment, there is a vast array of technology developed for utilization of hatcheries for salmon populations. The problems with the technology that have been developed is for the most part they have been aimed at the mass production of salmon. They have been aimed at introducing perhaps genetic and phenotypic uniformity, meeting human efficiency standards, and providing a standardized product out the other end.

This is not necessarily the commodity that the natural environment needs nor will put up with. Research evidence has shown that we need to vary this approach and that by varying the approach we can successfully change some of these characteristics we have introduced into salmon stocks through hatchery technology. Included in this technological development, there are some important aspects that we need to pay attention to. We can, in fact, mon-

itor life history changes. We can monitor genetic changes as they occur in the hatcheries if we choose to do the assessment.

The tools are there, and research is providing interestingly quite extensive tools for providing genetic and life history analyses. What we need to do is be able to utilize them, listen to what they tell us, collect the data to provide us with the information that will guide us in our tasks.

In the past, hatchery practices have, in fact, perhaps negatively impacted naturally spawning populations. I think there is adequate evidence to show this. However, on the positive side, hatcheries hold the capability to address restoration of naturally spawning stocks. We have the capability of doing this. What we need to do most specifically as far as I am concerned is to change what we might call standard operating procedures into something that gives us a little bit more versatility and a little bit more capability of addressing a multitude of needs. Thank you.

[The prepared statement of Mr. Hershberger can be found at the end of the hearing.]

Mrs. UNSOELD. Is it Koenings?

Mr. KOENINGS. Madam Chair, it is Koenings.

STATEMENT OF JEFFREY KOENINGS, CHIEF LIMNOLOGIST, ALASKA DEPARTMENT OF FISH AND GAME, JUNEAU, ALASKA

Mr. KOENINGS. Madam Chair and the rest of the committee, thank you for this opportunity to come before you today to discuss Alaska's fisheries program; in particular, our experience in culturing salmonids. In our approach to salmon stock restoration or supplementation, certain risks are acceptable. Others are not. But there always are risks. Moreover, we realize that risk, like beauty, lies in the eye of the beholder especially if the beholder lacks the necessary permit.

The State of Alaska focuses first on preventing loss of naturally spawning populations of salmon. For example, sustained yields from wild stocks were given preference in state statutes. Habitat is conserved. Hatchery production supplements but does not supplant production from wild stocks, and active genetic manipulation of wild stocks is not allowed. At the same time, Alaska has a world-class hatchery program.

How are the two compatible? First, the state's genetic and fish health policies guide the role of hatcheries either in the restoration of naturally spawning salmon populations or in salmon enhancement activities. These policies crafted by state, Federal, university, and user-group scientists control the manner in which the business of salmon restoration is conducted.

Second, Alaska, early on, recognized the necessity for state-of-the-art laboratories, well-trained scientists, and a professional cadre of fish culturists. Together, these specialists designed highly technical egg-take procedures, hatchery incubation guidelines, and fish transport protocols. Next came the constant re-evaluation of all critical procedures and the flexibility for rapid revision.

Finally, we realized that restoration projects are unique and accepted both the risk and failures as well as successes from designing protocols for one-of-a-kind situations. Some may argue that sup-

plementation does not work. I would be very careful about concluding that. However, careful planning, well-defined policies, and excellent science only reduce risk. Mistakes will be made and directions redefined. That is the very process that brings success.

The sockeye salmon hatchery program in Alaska is a good example. Hatcheries were used as early as the 1890's in Alaska to mitigate the loss of adult harvests due to overfishing by localized cannery operators. They were largely unsuccessful, and the canneries are no longer. In the 1940's and '50's, the Canadians experimented with sockeye culture and this too failed. Why? There were several factors. Overtaxing the food production in nursery lakes with hatchery fish was one but disease was another. A virulent virus known by the acronym IHN was the blame for the death of both the fish and the Canadian program.

Alaska re-entered the sockeye culture business in the 1970's with modern facilities and new equipment and good scientists. This early program suffered crippling losses to fish. The culture protocols were re-evaluated, and procedures were rapidly changed to "farm around" the disease. At reference to best management practices for hatcheries. This was a radical approach, but it paid off. Now Alaska is the world's largest and most successful sockeye hatchery program in the world. Had we followed conventional wisdom, this sockeye culture technology would not be available today. It can now be used to help in the supplemental of populations of sockeye in the Pacific Northwest. Thank you for the opportunity to be here today.

[The prepared statement of Mr. Koenings can be found at the end of the hearing.]

Mrs. UNSOELD. Mr. Sayre.

STATEMENT OF JOHN SAYRE, EXECUTIVE DIRECTOR, "LONG LIVE THE KINGS," WOODINVILLE, WASHINGTON

Mr. SAYRE. Thank you, Madam Chairman, and members of the committee. I am John Sayre, Executive Director of Long Live the Kings which is a private nonprofit corporation whose goal is the restoration of wild salmon runs in specific rivers in the Northwest, the enhancement of their habitat, and, equally important, the rebuilding of viable salmon economies that will support commercial, tribal, and recreational fisheries to the level of hopefully hundreds of millions of dollars generated in the Northwest economy each year and hundreds of thousands of visitors attracted to our area because of the salmon. Only 15 years ago, we had that situation. We don't have it right now.

Long Live the Kings is largely supported by private foundations, corporations, and individuals. In the last seven years, we have put about $2.5 million into private salmon enhancement efforts. And while we believe as the two previous speakers just said that wild spawning fish are best, they know how to do it all by themselves, they don't need human help, and they don't cost the taxpayers a dime, we have dozens, if not hundreds of salmon runs that need human help to probably recover.

Long Live the Kings has three specific projects that address where hatcheries could be used and where human help can inter-

vene that will help in the restoration of wild fish. And this is to answer the committee's specific questions that they have on how to do this. We are just in the process of completing this month the state-of-the-art facility at Lilliwaup on Hood Canal, and this is a project done in cooperation with state and Federal fishery agencies and the Indian nations, and it is to be a captive broodstock facility where you take a stock of wild fish that could potentially be listed as threatened or endangered.

And an example I would give would be the Dungeness River which flows into the straits in Washington State where you have only about 100 to 200 returning spawning adult chinook fish. And if somebody filed a petition on those fish, they would stand a good chance of getting listed. Through the concept of captive broodstock wherein you would go in and you would take eggs out of 25 reds or try to get 25 families of fish, you would take eggs out of their reds or nests in the river, the Department of Fisheries has developed a technique to take 300 to 400 eggs out of each red.

We would take those fish back into a hatchery situation, and you would raise them to sexual maturity in captivity. Some would be in freshwater, some would be in salt water to have a comparison of survival between the two. The reason for doing this is that with a small number of fish, at the end of four years you could potentially have a couple of million eggs that you could put back into the native river system. And this is a far, far higher survival than the wild fish could ever hope to achieve when their numbers are that low. This is an experimental project. It is being overseen by scientists of the agencies and the tribes, but this is one of the projects we have underway.

The second project is a supplementation project down in the Grays Harbor area where we have rivers that only reach their minimum escapement numbers of spawning fish three times in the last 20 years. We went in there with the local community people. We captured wild adult fish. We put the eggs into a hatchery system, raised them with the far greater level of survival that you get than in the wild, and then again put them back into their native river system. This year in three different rivers, we had major returns of wild fish down in the Chehalis Basin working with what is called the Chehalis Basin Fisheries Task Force, and we had tagged fish that did return, and most of them spawned naturally in the river which is a clear indicator that this program can work.

A third area that we are working with is we have taken a private hatchery, developed a private hatchery up in the San Juan Islands of Washington State where you have a water source, a spring that never had any fish in it at all. We developed a series of ponds. We initially got some stock from the Washington Department of Fisheries and developed a run of chinook salmon that now returns back into the bay itself 5,000 to 6,000 adult fish averaging 20 pounds apiece. These fish do not conflict with the wild fish. They came from a water source that had no wild fish. There are very few wild fish that come into the bay. There are none that spawn there. Those that come in are just wandering in from somewhere else.

This concept can develop commercial fisheries and recreational fisheries and have very little impact on remaining wild fish. These are three quick ideas on how hatcheries can play a positive role.

The last two things I would like to leave you with is to remember that with all of the stories about how desperate the plight is with fisheries, this is a remarkable resilient natural renewable resource. You can grow them faster than trees. They are still a recoverable resource, and we can still build a tremendous economy on salmon in the Northwest.

The last point is to do it, we have got to involve local communities. We have got to develop grassroots salmon enhancement efforts where the local people have an interest and an ownership in the fish and their restoration. That, combined with what could come from the Federal Government level, would work. Without the local involvement, I don't think it would work.

[The prepared statement of Mr. Sayre can be found at the end of the hearing.]

Mrs. UNSOELD. Dr. Kapuscinski.

STATEMENT OF ANNE KAPUSCINSKI, DEPARTMENT OF FISHERIES AND WILDLIFE, UNIVERSITY OF MINNESOTA, ST. PAUL, MINNESOTA

Ms. KAPUSCINSKI. Thank you, Madam Chair, and members of the committee. Thank you for inviting me to address you today. I am currently an Associate Professor of Fisheries and Conservation Biology at the University of Minnesota. I have extensive experience in salmon hatchery operations, in fish genetics and aquaculture research, and I have been involved in several Columbia River Basin efforts to improve genetic conservation in salmon hatchery programs. Also, I am very interested in this very important discussion today because I lived seven years in Oregon, and I am still a landholder there.

Hatcheries should be only one component of a comprehensive restoration strategy whose focus is to remove or greatly reduce the root causes of population declines such as the previous panel discussed with you regarding major problems with habitat loss and damage. The best possible role for hatcheries, in my opinion, is having a temporary hatchery whose objective is to rebuild a population while the causes of its decline are being reversed; for example, while efforts are underway to repair habitat.

There is much discussion in at least the Columbia River Basin region of another hatchery role called supplementation. This hatchery role is quite different from the one I just described because it involves long-term use of a hatchery, and the intent is that the hatchery-released fish will return as adults and interbreed with the naturally reproduced fish and that this will happen generation after generation.

The merit of supplementation is still an open question, and I believe it must be evaluated in a few test cases before we consider it for widespread use. In fact, there are plans underway to test supplementation in the Yakima/Klickitat Subbasin which is in Washington State, and I think that that kind of test should proceed.

When I talked about the use of temporary hatchery programs, the reason why I think that is the best use is, first of all, you then have a clear endpoint to spending dollars on the hatchery operations, and, secondly, if you achieve the objective, which is to succeed in restoring a population to self-sustainability through natural reproduction, you now also have an indicator that you have succeeded in improving the health of the ecosystem.

Restoration and assurance of long-term survival of salmon populations depends on maintaining their existing genetic diversity. But in 1991, I did an analysis of different hatchery policies and guidelines used in the Columbia River Basin, and my analysis showed that these policies are inadequate for maintaining genetic diversity. My recommendations called for improved quality and greater consistency in approaches of different agencies that are running hatcheries, and the report of my analysis is appended to my written testimony.

Changes are needed in hatchery operating guidelines; for example, guidelines on how to collect and which adult fish to collect, how to make matings of adults, all the way to guidelines on how smolts should be released. A comprehensive system for genetic risk assessment and for genetic monitoring of hatcheries is lacking although some necessary pieces do exist or are under development. As part of the Yakima/Klickitat Fisheries Project, I am on a scientific team which is currently developing genetic guidelines for day-to-day hatchery operations, for risk assessment, and for monitoring. And I believe that incentives are needed to encourage uniform application of these types of guidelines to all salmon hatchery programs.

We also need independent and scientifically based evaluations of all hatchery programs so that we can track their progress and whatever problems they cause in restoring naturally spawning populations and also so that we have the capability to make midcourse corrections in an informed way rather than doing it by trial and error.

And, finally, I think we really need improved coordination among the myriad agencies that are responsible either for managing different hatcheries or very often responsible for managing different parts of the ecosystems that salmon are a part of.

[The prepared statement of Ms. Kapuscinski can be found at the end of the hearing.]

Mrs. UNSOELD. Thank you very much. I will call on the other committee members first for your questions. The gentlewoman from Oregon.

Ms. FURSE. Dr. Koenings, in your testimony you mentioned a very astonishing fact, that your wild fish population had increased from 20 million fish in '71 to 150 million fish. In your opinion, what is the single most important element in the use of hatcheries for restoring the naturally spawning populations under your use of hatcheries?

Mr. KOENINGS. Again, to the Chair, in Alaska the rebound of the natural spawning population from the 1970's was principally due to better management practices, fisheries managers who were willing to make decisions to close fisheries, and get fish on the spawning grounds. The habitat is there. The two together took off, and now

we see from a low, as I said, of 20 million pieces harvested on average, now we have 150 to 200 million pieces being harvested.

Concurrent with that program because of the social and economic concerns over a lack of fish to harvest in the '70's, we established the Division of Fisheries Rehabilitation Enhancement and Development which now I am director of. This particular division was charged with the responsibility of building back the salmon runs. I think it speaks to the single factor that we have heard here today as alignment, if you will. In Alaska,the state, of course, is responsible for the management of its resources. It gave a single agency the responsibility to basically build the runs back, develop a hatchery program, develop the hatchery protocols, develop the various egg-take procedures, i.e., how you do business. It also learned very quickly that the biggest aspect of doing this correctly is learning how to control the people. Fish respond if the people are put to the right task.

So I think the key thing that we had was a single agency, you have a single group of people who are charged, both in terms of science and policy, with doing the program correctly. I think that is why it is successful today. We didn't have the myriad Federal groups, state groups, et cetera, all vying for a piece of the pie. There was one particular group that was made responsible. They put themselves to the task and are successful today because of it.

Ms. FURSE. Thank you. Mr. Sayre, I wonder if you could tell me what systems you have in place for monitoring and evaluating the success of your efforts—particularly life history and genetics? How do you monitor those?

Mr. SAYRE. Well, in terms of monitoring the success of the fish that come back, the technique is very simple in terms of tagging. But in terms of the genetics, we have the National Marine Fisheries Service's geneticist, Robin Wapples, in the Northwest, and in the Washington Department of Fisheries geneticist Jim Schackley have worked out the procedures by which we need to take fish and how to raise them with keeping families separate to get the proper genetic mix so that we are not doing damage. And I can't explain all that right here very well, but they have laid out very specific procedures for the genetic work.

Ms. FURSE. I have one more question if I may. Dr. Kapuscinski, I have read the Fish and Wildlife Service in the supplementation found that 25 out of 26 programs were successful, and Dr. Koenings has talked about successful restoration programs. In your opinion, is the risk of losing depleted populations greater than the risk of using supplementation to restore the populations? Given the risk of loss, how do we set a standard? Is it too high, or what is your response?

Ms. KAPUSCINSKI. I think it is difficult to really have one response. I think it depends on which populations you are looking at and what parts of the region they are in and also how severely declined they are. If you are getting very close to extinction, I think personally I would come on the side then of intervening, but hopefully that is the last resort, and intervening at that point and using hatcheries because, obviously, you can't reverse the causes that led to the population being near extinction fast enough.

I do feel that the way the supplementation has been used in Alaska is a very good example of its use. I am not completely sure that that plans for how it is going to be used in the other states in the Northwest are exactly the same, and I am also worried about comparing Alaska to the other Northwest states because my understanding is that the habitat in Alaska is in much better shape to begin with so it would make sense that the populations would rebound much more quickly with maybe even a lower level of human intervention via hatcheries.

So I don't know if that completely answers your question, but I think actually when I talked about the need for genetic risk assessment, that would be one thing if you were to go through a uniform process of risk assessment that would be one way you could answer your question, and you might decide in some cases the risk of losing the population is too great, and we should intervene with a well-designed hatchery program. And in other cases you might decide otherwise, and I think we have made a mistake in the region of coming up with just sort of one blanket answer, and the situations are pretty diverse, and I don't think we can continue to do that.

Ms. FURSE. Thank you.

Mrs. UNSOELD. The gentleman from California.

Mr. HAMBURG. Thank you. Mr. Sayre, I want to thank you particularly for your kind of looking at the upbeat side of things, the resilience of the salmon as a species and also pointing to the need for not only leadership at the Federal level but also this kind of grassroots efforts that have certainly been in evidence in the northern part of my congressional district. I don't know if you have heard of the work of the Mattole River Restoration Council, but that is a good example of a community trying to take hold of the destiny of a very important resource in their area. I think their efforts have been somewhat circumscribed though by not being able to really get a handle on the restoration of the entire watershed, and I think that is always going to be a problem so I think we do need the policy changes on the kind of macro level as well as the local community commitment, and I just appreciate that you pointed that out and what sometimes seems kind of a grim topic, but there are some good things that are happening and certainly some more good things that can happen.

Dr. Koenings, I wanted to ask you a question about the hatcheries and artificial propagation techniques being limited to one or two life cycles. You said that if we use prolonged supplementation techniques that this could result in the replacement of wild fish with hatchery fish, but my question is if the habitat is seriously degraded and the stocks are seriously depleted, is a limited supplementation really feasible—really possible?

Mr. KOENINGS. I guess an answer to that—a direct answer is probably no— because the habitat is intact, and we view the habitat basically as the driver for formation of the species—ecologically significant unit—however you want to define it. If the habitat is present, I think you can quickly restore stock through supplementation on one or two life cycles. If the habitat simply isn't there, one wonders whether you can recreate the species that was origi-

nally there when the habitat was in place, and I sort of question that.

Mr. HAMBURG. So in that case you do end up with the wild fish stock being replaced by the hatchery stock. That is just what happens?

Mr. KOENINGS. Yes, in our particular programs, and I don't pretend to be a geneticist, but we try to stay away from the F-1 generation. We complete our particular task, if you will, hopefully in one life cycle, and don't get into taking of eggs, if you will, from progeny once we have gone into a population and come back from that particular intervention. It is sort of circumspect, but that is how we do it.

Mr. HAMBURG. Can hatchery fish ever acquire the characteristics of a sustainable wild population?

Mr. KOENINGS. Oh, absolutely. We have had various examples in Alaska where we have taken fishless habitats, habitats that simply don't have fish for barrier reasons. Anadromous fish need to get upstream and spawn, of course, and when there is an impassable barrier there, one avenue that we use very successfully is to establish fish passes. Fish passes are only used by adult fish. However, first you have to get the young fish into the system to get the adult fish back to use the fish passes.

In the state, we have used hatchery technology to do that, where we have taken stocks out of one particular, although adjacent watersheds, and have applied those progeny to the unused habitat and have essentially created a naturally returning population of fish that are heavily harvested. One example I mention in my written testimony is Frazer Lake where populations of both sockeye and chinook salmon have established themselves and have been fished now regularly for, oh, almost a decade. Those populations are producing a harvest on the order of one million fish a year, sustainable through natural spawning.

Mr. KOENINGS. I know it wasn't me.

Mr. HAMBURG. Thank you. Dr. Hershberger, you noted that the behavior traits developed by hatchery fish are incompatible with survival in natural environments and suggested some means of avoiding development of those traits. Could you please elaborate on the alternative techniques and the feasibility of their implementation in the commercial hatcheries?

Mr. HERSHBERGER. For the most part, the indications are at the moment experimental so as far as the current implications that the feasibility of the application is going to have to await further development. But such simple things as broadcast feeding, nonpoint source feeding, changing timing of feeding has been shown to change behavior in a positive manner. There has even been some work with introducing predators. Fish can be trained. They are not stupid. And that I don't think anyone would want to put a ling cod in their raceway of salmon right now, but there may be techniques whereby we can incorporate that into standard hatchery procedures—fairly simple things that I think could be feasible given some developmental time, but the results right now are fairly preliminary, and there is work actively going on in that way.

Mr. HAMBURG. Could you comment a little more on the conservation hatcheries and the associated labor costs with that kind of technique?

Mr. HERSHBERGER. Conservation hatcheries would incorporate a fairly high labor cost because of the requirements, and what I am defining as a conservation hatchery is one that you have referred to where the habitat takes a period of time to be reintroduced and redeveloped. And, consequently, conservation hatcheries are dealing with two problems: one, maintaining the fish until we can develop the habitat again and, secondly, taking steps that aren't part of normal hatchery procedure to maintain the genetic integrity and variability that is still within that population. We seem not to want to make a move until we have to push the panic button, and so, consequently, the techniques involved with keeping that variability and making sure that you maintain that population are going to be much more intensive and much more costly than it would be under what I would call now normal hatchery procedures because of the care needed.

For example, this may be a little bit of—our first example is the Redfish Lake sockeye which is an active program now that is going underway. It has required the retooling of an entire hatchery for one thing and, incidentally, getting expertise from Alaska to learn how to raise sockeye. But on the other hand, they also put three foot banjo wire around the pump that supplies the water supply to assure that there was no "accidental" turnoff of water. Such as steps as these to take in this very panic-stricken approach are going to require more investment, and that may be a little bit of overkill, but that is what was done.

Mr. HAMBURG. Yes. Well, I think my time is up, but I want to thank the panel for your very good presentations, and there was certainly a lot of good food for thought for me and I am sure for the rest of the committee.

Mrs. UNSOELD. Dr. Koenings, I admire what Alaska did in the way of recovery on the wild species, but I am just green with envy when you talked about one agency. On the Columbia River, we have got at least five agencies, three states, plus the tribes, and dealing with hatcheries alone we have got three types: the Feds, the states, the tribes all have hatcheries. It becomes very much more complicated, and who is accountable for the success or failure of the Columbia River hatchery system? Anybody want to dabble in that one?

Mr. KOENINGS. I will take a shot at that one.

Mrs. UNSOELD. OK.

Ms. KAPUSCINSKI. I will take a shot too.

Mrs. UNSOELD. Anyone want to offer who should be?

Ms. KAPUSCINSKI. I will take a shot. Well, as you probably realize, the problem is that no one group is accountable, and, instead, just different agencies are accountable simply for one particular hatchery, and you have to understand that historically what was viewed as the objective in the hatchery was to put out the most number of smolts, and so those agencies felt initially that they were doing a good job because they were putting out a lot of smolts. It took a long time for the ocean and the freshwater ecosystem to show us that that alone was not working, but it is important to un-

derstand that history because the goal initially wasn't really clearly to restore naturally spawning populations.

In terms of who should be accountable, I have wondered why when the Northwest Power Planning Act was passed that created the Northwest Power Planning Council, that council was given the responsibility of trying to foster interagency coordination, but it doesn't have very much authority over that. And I don't know what the pluses and minuses of giving them the authority would be, but that is at least one thing that Congress should maybe consider if you already have one organization in place that has been dealing for a long time with trying to get the different groups to communicate.

And, by the way, they have recently come out with a strategy for salmon which took a tremendous amount of work and dialog and communication among the different groups, and I think it has a lot of very useful and innovative elements for it. And it clearly calls for a holistic approach. It echoes almost everything you have heard from the two panels today and, for example, calls for the use of hatcheries in a way that is very well integrated with habitat restoration.

Mrs. UNSOELD. I commend you, Dr. Kapuscinski, for being so familiar with our problems in the Northwest. Does anyone else want to—yes, go ahead.

Mr. KOENINGS. I will make a comment in a more serious vein. There is a need to align policies and procedures in doing business with culturing fish. There is no question about that, and some of the practices in terms of hatchery operation at the Federal level have been abysmal in terms of my reviewing them, if you will, when we got into the hatchery business in the State of Alaska.

On the other hand, you need the idea of having a coordinating group that represents the Pacific Northwest. I believe the Federal Government is the agency to lead that particular charge. I think on the other hand—I want to add though that there are a lot of local concerns that the individual states might have. It is not simply the idea of aligning Federal agencies. I think you need to get into the idea of aligning those agencies or that coordinating body with the states' interest as well. That coordinated kind of alignment will go forth and do the business of restoring these population of fish. Don't leave out the states and their management authorities.

Mrs. UNSOELD. Both panels, it seems to me, point out that we have been forced to turn to the Endangered Species Act to try to change some of the practices that have failed to take into consideration a prevention program. The ESA should not be called upon except how did somebody in the other panel put it?—that it is really an emergency measure and should not have to be the primary tool. But as we think about the Columbia River hatchery system, is the system fulfilling existing Federal obligations and meeting the goals and intent of various fish production and resource management plans? It may have been created originally to just increase the number of smolts, but how do we give it a new alignment or direction to not only handle our current emergency but to put us on a preventive program?

Mr. HERSHBERGER. I think one of the things that needs to be done particularly—the Columbia River is an extremely complex situation. There is not going to be a single answer. You don't realize that until you look at the myriad of agencies and the myriad of things that have been done on there and so forth and so on. And I think what we need to do is perhaps from the hatchery perspective incorporate a bit more versatility in the program than has been done previously. Hatcheries have been defined in a framework and utilized in a framework that is rather narrow. And by expanding this to address the specific needs and to fit into the system where they should be fitting in rather—right now it is amazing to me, but the situation is when smolts are released in the Columbia River from the top to the bottom where we have hatcheries, it is done within an eight week period of time.

Formally, we had salmon going in and out of that river 12 months a year. Now, that to me says a lot of standardization and a lot of problems. We have to conduct operations in one specific manner and particular point in time, and generally it is aimed at human efficiency. We need to get rid of that framework, and I think that would go a long way of addressing a lot of the problems that we have with the hatcheries particularly not meeting the management goals.

Mrs. UNSOELD. Did you want to respond?

Ms. KAPUSCINSKI. Yes. I would just like to add that another element of fitting hatcheries into the needs of the natural system is to take a subbasin which is really another way of talking about a watershed approach to making decisions on a subbasin basis in the Columbia River Basin, and I think that is one of the strong elements of the salmon strategy that the Power Planning Council has put out.

Mrs. UNSOELD. Mr. Hamburg, did you want to ask additional questions?

Mr. HAMBURG. No, not at this time.

Mrs. UNSOELD. I will ask one then. Dr. Kapuscinski noted that there are many hatcheries with incomplete guidelines for minimizing genetic risk to the salmon populations, and, Mr. Sayre, I would like to ask what guidelines your organization uses?

Mr. SAYRE. Well, we have had available to us some of the best minds and fisheries in the Northwest who have developed guidelines for us, but they are certainly not a common set of guidelines. One of the things I would love to see is the fishery scientists need to give us some direction in this area, in areas where we should manage specifically a watershed for wild fish, or in other areas where you probably should manage for hatchery production because you have certain areas of Puget Sound—I believe, it is safe to say that you have had fish dumped in these rivers from sources all over the Northwest for the last 60 to 70 years, and what kind of fish they are is anybody's guess.

But I would love to see some direction in that area because as you well know we have in Washington State these regional fishery enhancement groups that were set up under state law and are financed by a surcharge in sport and commercial licenses, and they are working to try to rebuild within their particular—and this is based on watersheds—within their watersheds on how to enhance

salmon. And these questions are unanswered. They need some clear direction, and I don't know whether it is a panel that the government sets up or somebody sets up to direct these people as to where they should work on wild fish, and if they are going to have hatcheries, how should the hatchery be operated, what stock should it use, et cetera. And that would be a tremendous asset right now because you do have a tremendous groundswell of local people who want to get involved, and they do need some direction.

Mrs. UNSOELD. Yes?

Ms. KAPUSCINSKI. I really agree with those comments, and that is why I referred in my testimony to the work that is going on in the Yakima fisheries project. I should make clear that this team of scientists of primarily geneticists are developing these hatchery-operating guidelines and risk assessment monitoring guidelines, but they are not going to be just for use in the Yakima Basin. We were asked, in fact, very early on in the task to try to make them as generic as possible. And ultimately we are expecting to have them in the kind of handbook, very user friendly, format so that different parties trying to use hatcheries have that kind of clear direction. And they do have to be flexible. Versatility has to be an element of those guidelines, but Mr. Sayre is correct that up to now although a lot of that knowledge of how to do this was held in the minds of different scientists, it hasn't been compiled very well and presented in a user friendly manner.

Mrs. UNSOELD. Yes. Dr. Koenings.

Mr. KOENINGS. I will respond from the viewpoint of Alaska's program.

Mrs. UNSOELD. I am sorry. Speak into the mike.

Mr. KOENINGS. I am sorry. I was going to respond more from the origins of the Alaska program and will sort of mirror the comments here. What we had in place before we started the program were policies that looked at genetic impacts, policies that looked at the effect of fish diseases, policies that said this is the way we are going to do business. This allowed the public to know what was allowable and what was not allowable and also, of course, guided the program from the start. We are in the same sort of boat now when we are looking at shellfish farming in the state. We don't have policies directed toward shellfish in terms of disease or in terms of genetics at present. But we are building those policies before the farms begin operating.

That is the kind of thing I think is necessary here—to get a policy developed clearly from the scientific point of view but also from the point of view of informing the public what is allowable and what isn't. And once you have done that, you have brought the two groups together in terms of forming a team, and that buys stewardship of the resource. And once you have established that, I think you have got a lot of the battle already won.

Mrs. UNSOELD. Do any of the panel members have anything else that they would like to add to the record at this point? Mr. Sayre.

Mr. SAYRE. Just to say on this very subject, I have been talking with some other organizations and some of Dr. Hershberger's colleagues at UW is whether we can pull together a group of fishery scientists to address this specific problem in the next few months and set up some kind of meeting or whatever that hopefully would

produce a document along those lines that could go to these regional fisheries groups and others on what to do if they want to work with wild fish and what to do if they are going to work with the hatchery, and this may already exist.

Ms. KAPUSCINSKI. Well, I think it is under development, and I think what will be important once the drafts come out is that they undergo very high quality scientific peer review, and then once they are revised appropriately, then where Congress might be able to help us is to provide incentives for those guidelines to be used because, otherwise, they are not worth very much if they are just published and not used.

One final point I will make is that some of the last comments reminded me that there are efforts starting now in the Columbia River Basin to try to develop integrated hatchery policies because the agencies have realized, I think, partly as a result of my former analysis that there was a problem so there is a group, for example, called the Integrated Hatchery Operations Team that is trying to do this, and it remains to be seen what they are going to come up with, and the quality of it will also need to be reviewed. But I think that is a promising sign, that agencies, both state and Federal, are starting to work together to do that. And what we need to do now is encourage that in the rest of the salmon ecosystems in Oregon, Washington, and Idaho and California.

Mrs. UNSOELD. I would like to thank this panel and the previous panel and leave one thought with you, that as you are working on these problems and trying to take an ecosystem approach, trying to look at the big picture, that even if we are to accomplish everything that all of you have suggested and get human nature to want to change its ways, it will be for not if we don't do something on this globe to address human population. And that has got to override all of our considerations in environmental issues, but I thank you all very, very much, and the record will stay open for two weeks if any of you have any specific suggestions on legislation that you think we should undertake. Thank you very, very much. The meeting is adjourned.

[Whereupon, at 12:15 p.m., the subcommittee was adjourned, and the following was submitted for the record:]

ONE HUNDRED THIRD CONGRESS

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U.S. House of Representatives
Committee on
Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, DC 20515-6230

BACKGROUND MEMORANDUM

TO: Members
Subcommittee on Environment and Natural Resources

FROM: Subcommittee Staff

DATE: March 4, 1993

SUBJECT: Hearing on Watershed Management and Fish Hatchery Practices in the Pacific Northwest

On Tuesday, March 9, at 10:00AM, the Subcommittee on Environment and Natural Resources will conduct a hearing on watershed habitat restoration and the role of hatcheries in the restoration of fish populations in the Pacific Northwest. Witnesses will include representatives from the University of Washington, the University of Minnesota, The Pacific Rivers Council, the Alaska Department of Fish and Game, and private consultants.

This hearing is the first in a series on the management and restoration of the nation's rivers. There will be two panels, the first of which will focus on the scientific consensus on whether watershed management will be a useful tool in the restoration of riverine ecosystems and fish populations. The second panel will focus on the role that hatcheries will play in the restoration of fish populations in the Pacific Northwest. The hearing is not intended to recommend measures for compliance with the Endangered Species Act as it relates to spotted owls, the Timber Summit, or endangered salmon.

BACKGROUND

Most of the nation's rivers have been experiencing a general decline in their health. One of the best indicators of the decline in ecosystem health is population reduction in river dependent organisms. In the Pacific Northwest (Washington, Oregon, northern California, and Idaho) salmon populations have been the focus of the decline in the health river ecosystems. According to the American Fisheries Society, over 100 salmonid populations are extinct with over 210 additional salmonid populations currently at risk of extinction. While the salmon draw much of the attention, many biologists believe that the decline in the numbers of salmon is indicative of a general

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decline in the health of Pacific Northwest riverine ecosystems.

There could be severe economic impacts for the Pacific Northwest if salmon populations continue to decline. It has been estimated that the direct, indirect, and induced economic stimulus of the fishing industry produces over $1 billion in personal income per year and supports over 60,000 jobs in the region. These numbers represent the economic effect from a resource that is in a severely degraded state; the potential economic return from a healthy ecosystem would be greater.

Many causes for the decline of salmon have been identified: urbanization; agricultural practices; logging; construction and operation of dams; over harvesting; and road building. All of these factors combine to create cumulative losses of riverine habitat and watershed ecosystems However, the American Fisheries Society has identified habitat loss as the most consistent contributor to the decline of salmon populations.

In addition to habitat loss, traditional hatchery practices have also been identified as contributing to the decline of wild salmon populations in the Pacific Northwest. In essence, the problems with hatcheries are associated with the "feed-lot mentality" evident in traditional hatchery systems. In other words, hatchery managers have often focused on producing large numbers of juvenile salmon, as opposed to a goal of producing fish that will have the capability, as adults, to return and spawn naturally.

The role of habitat protection and hatchery practices on the restoration of naturally-spawning salmon populations will be the focus of the hearing. As part of this goal, the benefit of managing rivers on an ecosystem or watershed basis will be explored.

HABITAT PROTECTION AND RESTORATION ON A WATERSHED BASIS

Management of rivers on the level of ecosystems or watersheds seems to make intuitive sense, but it presents some very practical problems. Watershed management seems to be a catch-phrase that has yet to be adequately explained. The purpose of this panel of the hearing is to explore methods of identifying and restoring habitat necessary for ecosystem health and the survival of naturally spawning salmon populations.

The availability of adequate habitat is very important to the survival of salmon. Salmon require stream beds with gravel of a particular size in order to lay eggs. The water must have enough oxygen and be relatively free of pollutants for the eggs to hatch. Too much silt in the streams can cover the eggs and deprive them of oxygen. In addition to the chemical properties of the water, the presence of vegetation on the stream and river edges also has important consequences for the survival of salmon.

The area on the edge of rivers and streams is called the riparian zone or riparian habitat. The riparian zone extends from the high water mark of the stream channel to upland terrestrial areas that are influenced by the stream. Research suggests that riparian zones may be the key landscape feature that controls ecological functions in stream corridors. Some of the functions of the riparian zone that are important to salmon include: maintaining the proper light and temperature regime; providing nourishment to prey species that salmon feed upon; acting as a source of large woody debris which provides refuge from predators. Riparian zones also influence the flow of water and pollutants from upland areas and provides habitat for many wildlife species. The decline in the health in riparian habitat, as indicated by the American Fisheries Society, estimate that at least 132 animals associated with riparian habitat are at risk of extinction. It will be impossible to maintain current salmon populations or have any hope of restoring populations to historic levels without protection and restoration of stream and riparian habitat.

Riverine habitat degradation is a problem across the nation. According to Dr. James Karr of the University of Washington, of the 5.2 million kilometers of rivers in the U.S., only two percent are healthy enough to be considered high quality. The biological consequences of human activities have been equally severe. Between 20-73 percent of riverine populations of fishes, mollusks, and crayfishes studied can be classified as rare to extinct. This compares with only 11-14 percent of terrestrial species being so classified. This degradation of riverine ecosystems has occurred despite legislation meant to protect rivers (e.g. the Clean Water Act). It has been suggested that part of the problem with the present regime is that it does not take into account the whole river ecosystem. Furthermore, there appears to be a growing consensus that we need to change the way in which we view rivers in order to more effectively protect them.

Most people, when they think of a river, think only of the water flowing through a channel. This viewpoint is epitomized in the federal Clean Water Act. The implementation of the Clean Water Act assumed that if one protects the chemical properties of water, then one protects the rivers. This viewpoint fails to recognize the complexity of a complete riverine ecosystem and perhaps has contributed to the decline in our rivers. It has been suggested that we change the way in which we look at rivers to an ecosystem or "watershed" basis. While there is no scientific consensus of the definition of a watershed, it can generally be described as the entire physical area or catchment basin drained by a distinct stream or river system physically separated from other watersheds by ridgetop boundaries.

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THE POTENTIAL ROLE FOR HATCHERIES IN THE RESTORATION OF NATURALLY-SPAWNING SALMON POPULATIONS

Hatcheries have been a part of fisheries management since the 1870's. However, it has been in the Pacific Northwest, and especially the Columbia River, that they have been used most widely. The State of Washington alone has 121 major public hatcheries. By some estimates, this number is greater than any other state or province in North America and perhaps the world. The impetus for the rapid growth in the number of hatcheries is largely related to two ideas: (1) hatcheries can be used to mitigate the effects of habitat loss due to human activities; and (2) in addition to mitigation, hatcheries can improve upon nature and increase the number of salmon available for harvest.

The construction of dams, timber harvest, and agricultural water diversion were the major human activities that used hatcheries to mitigate the loss of salmon habitat. It was assumed that by building hatcheries to replace the amount of natural salmon production, there would be no decrease in the number of salmon. In many cases, this has not proved to be true. Despite an ever increasing number of juveniles released from hatcheries, the number of returning adults has continued to decline. These trends indicate that many hatcheries have not been able to mitigate for man-made activities in many watersheds.

In addition, hatchery practices themselves have been implicated in the decline of salmon populations. In the words of one fisheries biologist, "hatchery production...creates fat and stupid juvenile fish". These "fat and stupid" salmon have been reared in increasingly artificial hatchery facilities. In these hatcheries, they learn habits that do not serve them well in the wild. Juvenile fish from hatcheries are not as well adapted as "wild" salmon for avoiding predators, foraging in the wild, or using natural resting sites in their run downstream. Because of this, their survival rate upon release is low when compared with wild stocks. In spite of their decreased ability to survive in the wild, they can compete with wild populations of juvenile salmon for food and habitat. So, not only are hatchery fish less able to survive in the wild, they may decrease the survivability of wild populations of salmon that would survive better in the absence of hatchery fish.

Hatchery reared fish also have problems with disease. When rearing salmon in extremely concentrated conditions, diseases often crop up. Upon release, disease carrying hatchery salmon may infect wild populations and thus, further diminish the number of wild salmon.

The most recent area of concern for reforming hatcheries lies in the field of population genetics. Individual populations of salmon are the result of natural selection. The end result is a

stock of fish that is highly adapted for one and only one stream. Hatcheries have disrupted this system of natural selection and replaced it with "unnatural" selection. Hatcheries have not traditionally chosen stocks for their ability to survive in the wild or to return and spawn naturally. This practice also has negative consequences for wild populations of salmon. Hatchery fish can interbred with wild fish and thus may reduce survivability of the offspring if the life history traits of the wild and hatchery fish are dissimilar.

There has been a recognition of these problems by some hatchery managers, and this has lead to reform in recent years. The term "supplementation" has been given to describe some of these reforms. Supplementation means the artificial propagation and stocking of locally adapted juvenile fish into the natural environment to increase wild, naturally spawning populations. This procedure has been successfully utilized for a variety of stocks in diverse areas including: fall Chinook salmon in the Hanford reach of the Columbia River; Chinook in the Frazer River of Alaska; sockeye in Alaska and Lake Washington, Seattle; American shad in the Susquehanna River, Pennsylvania; and Atlantic salmon in Newfoundland, New Brunswick, and Nova Scotia. Furthermore, the Fish and Wildlife Service, in a 1990 study, identified 26 true supplementation projects (as distinguished from harvest augmentation projects). Of these 26 supplementation projects, 25 were considered successful by their principal investigators.

These examples appear to offer a role for hatcheries in the restoration of declining populations of salmon in the Pacific Northwest provided that appropriate habitat is protected or restored. One must remember that some of the problems with hatcheries (e.g. disease) are inherent--they can only be reduced, never eliminated. However, the salmon populations of the Pacific Northwest are so severely degraded, it appears that properly managed hatcheries can play some role in their restoration.

WATERSHED AND HABITAT ISSUES

Can naturally-spawning salmon populations be restored without riparian habitat protection? Can we identify the riparian habitat that is critical to salmon restoration? Are the lessons learned from the experience of the Pacific Northwest applicable to river ecosystems nationwide?

While management of river systems seems to be a practical, "common-sense" solution, it remains unclear how this will work operationally. What are the attributes of a healthy watershed? What solution are available to us for habitat restoration? How will "watershed management" differ from the present management system?

The present system of riverine management involves many overlapping jurisdictions, including tribal, state, and federal

management agencies. Will watershed management mean coordinating all of these various organizations or replacing them with a "watershed authority"?

Finally, there have already been attempts to coordinate management on a regional level (i.e. the Northwest Power Planning Council). In spite of this, the region's aquatic biota have continued to decline. How will a new watershed management regime balance ecological interests with all of the other interests represented in the region (e.g. agriculture, hydropower, shipping)?

HATCHERY ISSUES

Does the current system of hatcheries in the Pacific Northwest have a role to play in the restoration of naturally-spawning salmon populations?

There is large institutional inertia for maintaining the status quo with respect to hatchery operations. What can be done in order to ensure that hatcheries continue with recent reforms? As part of this problem, how will we effectively monitor any changes that are implemented?

As has been noted, many salmon populations have already gone extinct. If naturally-spawning salmon are to return to these barren areas, they must come from other streams. Will this create the same problems that have already been mentioned?

Hatcheries in the Pacific Northwest come under many jurisdictions. Will restoration of naturally-spawning populations require integration of all of these hatcheries? Can this be accomplished with present regulatory authority?

RESTORATION OF WATERSHEDS AND NATURALLY-SPAWNING SALMON POPULATIONS IN THE PACIFIC NORTHWEST

TESTIMONY OF

DR. ROBERT J. NAIMAN, DIRECTOR, THE CENTER FOR STREAMSIDE STUDIES
UNIVERSITY OF WASHINGTON, SEATTLE, AND

KEVIN L. FETHERSTON, THE CENTER FOR STREAMSIDE STUDIES
UNIVERSITY OF WASHINGTON, SEATTLE

BEFORE THE

U.S. HOUSE OF REPRESENTATIVES SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES, COMMITTEE ON MERCHANT MARINE AND FISHERIES, MARCH 9, 1993

Mr. Chairman, thank you for inviting us to appear before you and the subcommittee to address issues concerning the management of watersheds and naturally-spawning salmon populations in the Pacific Northwest.

Healthy watersheds are essential to the social, economic, and ecologic well-being of all who inhabit the Pacific Northwest region. This includes fishermen working our Pacific coastal waters, the growing human population benefiting from locally available clean drinking water and hydroelectric power, and the families who vacation along the beautiful rivers and streams of our National and State Parks. Healthy watersheds are also essential for naturally spawning salmon and the myriad other living creatures that collectively make up the living fabric of our rivers and streams. The social and economic quality of the Pacific Northwest will be greatly diminished if we do not maintain the biotic integrity of our region's rivers and streams.

The watersheds and rivers of the Pacific Northwest are presently moving toward a level of biotic impoverishment that will be in large part irreversible. Indeed, the fate of the imperiled Pacific salmon, the collective symbol of the Pacific Northwest people, is dependant upon the biotic and physical integrity of the region's watersheds, rivers, and streams. However, this imminent loss is preventable. Prevention will require a new approach to watershed health taken from the ecosystem perspective. In addition, there are no adequate scientific or management infrastructures to deal with the scale of the crisis at hand. We need a new interdisciplinary, inter-agency, and inter-university initiative in the Pacific Northwest where watershed-level issues can be defined and solved. Innovative approaches to watershed and river restoration and management must be developed, tested, and taught to future professional resource stewards of the Pacific

Northwest. We have a responsibility as a people to pass on to future generations a different legacy than biologic, economic, and social impoverishment. We can leave a regional legacy of ecological health founded upon an ecosystem perspective toward the restoration and sustainable use of our rivers, streams and watersheds.

The key points of this testimony are summarized in Table 1.

I The Ecological Health of Pacific Northwest Watersheds Under Present Management Regimes

Rivers and Streams

Historic, and existing public and private land-use in the Pacific Northwest, have simplified the natural structural complexity and hydrology of the region's rivers and streams (Bisson et al. 1992; Seddell and Froggatt 1984). In other words, our rivers have been straightened, stripped of their streamside forests, isolated from streamside wetlands, and cleared of the in-stream woody debris that provides essential habitat for salmon, other fish and aquatic organisms, and riparian wildlife. Loss and degradation of riparian forests is extensive throughout the Pacific Northwest due to past and present forest management practices, development pressures, and the invasion of exotic plant species (Sedell and Froggatt 1984). Riparian forest degradation has resulted in loss of stream and river habitat complexity (Bisson and Sedell 1984; Grant 1986).

Sustainable management practices for riparian forests are lacking. Maintaining biological diversity and fish habitat involves much more than the present set-aside forest buffer strips (Naiman et al. 1992). Indeed, ecosystem management of riparian forests is synonymous with managing fish habitat complexity (Sedell et al. 1989).

The natural river and stream flow patterns of virtually all Pacific Northwest rivers and streams have been altered as a result of historic land-use. Alterations include: dams, water withdrawl for irrigation, river channelization for flood control, diking of river floodplains for agriculture, forest management practices, and cattle grazing. The consequent modifications of river flow, physical channel properties, and sediment movement appear as cumulative effects throughout the river network (Simenstad et al. 1992). The cumulative result of decades of poor land-use practices in the Pacific Northwest has been the loss of the capacity of our rivers to support historic numbers of fish and other aquatic organisms (Bisson et al. 1992).

Table 1: WATERSHED RESTORATION AND NATURALLY-SPAWNING SALMON POPULATIONS - KEY POINTS

- Ecological health of Pacific Northwest riverine corridors is declining.
- Existing state and federal land management practices will continue the incremental decline in watershed health and fish populations.
- Effective management requires an ecosystem perspective to restore and maintain the ecological vitality of riverine systems. This perspective includes all organisms, not just salmonids.
- Ecologically effective riparian management zones extend up the drainage network into non-fish bearing streams. This does not exclude some commodity extraction, as appropriate knowledge and technologies are developed.
- There is an urgent need for a Pacific Northwest regional initiative or center for watershed management which transcends political barriers, institutional structures, and philosophical approaches and disciplines.
- There are substantial economic and social benefits to managing rivers on a watershed basis that accrue directly to human populations and the environment.

Fish Populations

In this century fish populations of the Pacific Northwest have been profoundly diminished along with much of the regions unique character (Eley and Watkins 1991). More than 200 distinct stocks (genetically distinct fish populations native to a particular drainage system; Bisson et al. 1992) of anadromous salmon in the western United States are presently at risk of becoming extinct (Nehlsen et al. 1991). Of the Pacific salmon, steelhead, and sea-run cutthroat trout once common in the states of the Pacific Coast, 106 are extinct, 102 are endangered, 58 are at moderate risk, and 54 are a matter of concern (Nehlsen et al. 1991). For example, populations of naturally spawning salmonids in the Columbia River have declined by more than 95%. This precipitous decline in salmon populations is indicative of the progressive degradation of our region's watersheds.

Habitat destruction, overfishing, and harmful interbreeding of wild and hatchery fish have been implicated in the observed declines of Pacific Northwest salmon stock abundance (Nehlsen 1991, Bisson et al. 1992). Existing fish culture practices have resulted in an overall loss of genetic diversity among wild fish populations (Bisson et al. 1992, Allendorf et al. 1987). State fish hatcheries' programs address the symptoms of the decline of salmon populations, but do not address the real problems of overharvest and habitat degradation (Meffe 1992). Furthermore, hatchery fish are being released into degraded riverine systems that are largely unsuitable for survival, reproduction, or migration (Meffe 1992). In final analysis, the future of the Pacific salmon depends upon the preservation and restoration of its wild populations and their habitats through management based on an ecosystem perspective (Frissell 1992, Maclean and Evans 1981, Nehlsen et al. 1991).

II Fundamental Elements of Ecologically Healthy Watersheds and Fish Habitat in the Pacific Northwest

Four fundamental components comprise ecologically healthy watersheds in the Pacific Northwest (Naiman et al. 1992). These are: 1) basin geomorphology as it relates to natural disturbance regimes, 2) hydrologic patterns, 3) riparian forests, and 4) diverse and abundant habitat.

Basin Geomorphology

Basin geomorphology (landform development in river drainage basins) in ecologically healthy watersheds is determined by the type, frequency, and intensity of natural disturbances. Recent studies in the Pacific Northwest have shown that the delivery and routing of water, sediment, and woody debris to streams are the key processes regulating the vitality of watersheds and their drainage networks (Naiman et al. 1992). The natural occurrence of these disturbances is essential to the health of the watershed. For

example, landslides occur at a magnitude and frequency characteristic of a specific landscape and geologic setting. Landslides deliver new sediment and gravel to river channels where it is sorted by flowing waters into spawning beds and used by the next generation of salmon. Landslides are thus integral to the health of salmon populations *when they occur at natural frequencies.* In turn, the salmon are genetically adapted to such geologic conditions within their river of origin. However, an increase in landslide frequency and magnitude within a watershed due to poor land-use management, such as road building on steep unstable slopes, results in deleterious downstream impacts on fish populations, on the riparian forest, and on the full array of organisms using the riverine corridor.

Hydrologic Patterns

Hydrologic patterns of ecologically healthy watersheds in the Pacific Northwest are a function of the timing and quantity of stream flow, characteristics of seasonal water storage and source area, and the dynamics of surface-subsurface exchanges (Naiman et al. 1992). Water flow in natural rivers is a complex pattern of fast and slow current velocities, eddies, and backwater pools. The complexity of stream flow creates a rich variety of habitats that harbor a large community of diverse plants and animals. In addition, flooding plays a significant role in structuring the riparian forests throughout much of the river system. For example, floods disturb existing vegetation (i.e. physically remove or damage), and reconfigure landforms in active river channels.

When the natural variation in stream discharge and water level is suppressed by water diversions, dams, and channelization, many of the varied stream and riparian forest habitats disappear along with much of the diverse flora and fauna that depend on their existence. The flow of water from headwater streams to oceans creates strong physical and ecological links between stream reaches that are otherwise separated geographically. Ecologically healthy watersheds require these lateral, longitudinal, and vertical hydrologic linkages between aquatic habitats. Because rivers and streams are a continuum of physical and biotic processes the effects of manipulations at one site are never confined to that one location. Thus, site-specific solutions are an ineffective approach to watershed management.

Riparian Forests

Riparian forests are the heart of an ecologically healthy watershed (Décamps and Naiman 1989, Naiman and Décamps 1990). The riparian zone extends from the edge of the average high water mark of the river or stream toward the uplands (Figure 1) (Naiman et al. 1992). This zone includes terrestrial areas where vegetation and microclimate are influenced by perennial or intermittent water associated with high water tables, and by the ability of soils to hold water. Higher in elevation is the riparian "zone of influence," a

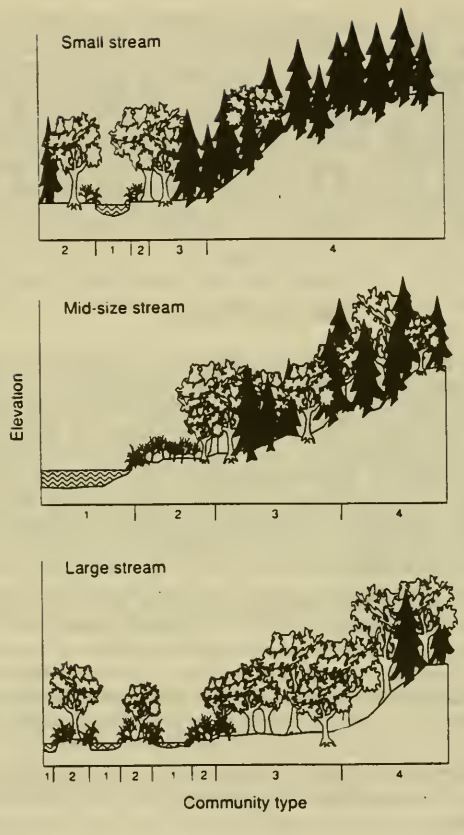

Figure 1. The natural characteristics of the riparian zone change with stream size. In low- and mid-order streams the links between the riparian forest and the stream are strong. In large rivers the links are not aas strong in the main channel butthey do remain strong in the secondary channel. KEY: (1) active channel, (2) riparian zone, (3) zone of influence, (4) uplands. Note that (2) and (3) make up the complete riparian zone of influnce (Naiman 1992).

transition area between the riparian zone and the upland forest where vegetation still influences the stream under some conditions (Gregory et al. 1991). The riparian forest is shaped by channel geomorphology, frequency, magnitude, and timing of flooding, the spatial position of the channel in the watershed, and the disturbance regimes (Naiman et al. 1992). The maintenance of riparian forests in their historic abundance and condition is essential to the long term vitality of a watershed.

Riparian forests provide a number of ecological services to the stream. These include:

1) Control of stream temperature resulting in part from the density of the tree canopy in forested streams. Stream temperature is critical in spawning and rearing habitat, and plays a role in the level of aquatic productivity.

2) The addition of large amounts of leaves, cones, wood, and dissolved nutrients to streams (Gregory et al. 1991). These materials are sources of nourishment for the aquatic organisms living in the streams.

3) Contribution of large woody debris in healthy forested streams large woody debris is the principle factor structuring aquatic habitats (Naiman et al. 1992). Without this woody structure stream biodiversity and carrying capacity for fish are greatly diminished. Large wood also shapes the stream channel structure and its ecological processes.

4) The foundation for wildlife habitat including thermal and resting cover, corridors for migration and substrate for substantial biological activity by microorganisms, invertebrates, and other aquatic organisms (Naiman 1990, Gregory et al. 1991, Naiman et al. 1992).

The biotic complexity provided by a functional riparian forest is essential to the ecological health of rivers and streams.

Habitat Characteristics

In ecologically healthy watersheds, there are strong interactions between river and stream channel geomorphology, hydrology, spatial position of the channel, and the riparian forest that provides habitat for terrestrial and aquatic organisms (Naiman et al. 1992). The result of these interactions is habitat complexity and variety. Gradients in current velocity and temperature, patches of rock and gravel of different sizes, piles of branches and leaves, small dams formed by dead trees and a multitude of other distinct patches created by the complex interplay between water movement, geologic events and riparian vegetation all provide the diversity of habitats required by a rich commmuity of organisms for shelter, food, and reproduction.

Ecologically healthy watersheds provide a complex array of stream conditions which are used directly by a variety of species at some point in their life-cycle (Everest 1987). Stream temperatures vary throughout river networks depending upon the density of riparian forest canopy, stream depth, presence of groundwater seepage and other factors. All fish populations are adapted to local temperature regimes. Significant alterations of these regimes result in the disruption of important life cycle events, such as the timing of migrations (Beschta et al. 1987, Naiman et al. 1992).

Available evidence suggests that ecologically healthy watersheds are maintained by an active natural disturbance regime operating over time scales ranging from days to centuries and spatial scales from inches to thousands of square miles. Because each scale influences the others, the effects of altering one cannot be isolated and may have consequences far removed both geographically and temporally. Ecologically healthy watersheds are dependent on the nature of the disturbance (e.g. fire, landslides, channel migration) and the ability of the system to adjust to constantly changing conditions. The natural disturbance regime produces a dynamic equilibrium for riparian forests, habitats, water storage, water quality, animal migration, and biodiversity resulting in resilient and productive ecosystems. The net result is an ecological system, at the watershed scale, which possesses a biotic integrity strongly valued for its long-term social, economic, and ecological characteristics (Naiman et al. 1992).

III Are Existing State and Federal Land Management Regimes Adequate To Prevent Further Watershed and Fish Habitat Degradation?

Existing state and federal land management regimes and regulations in the Pacific Northwest do not contain provisions adequate to prevent the further degradation of the region's watersheds and fish habitat. Regionally, only the state of Washington is developing watershed level management goals and programs (i.e., the Washington Timber, Fish and Wildlife Agreement 1987) and these remain inadequate. The absence of regionally-articulated goals for an integrated watershed health plan can only be understood as a failure of the local, state, and federal land management programs to perceive the rate and scale of degradation in Pacific Northwest watersheds, rivers, streams, and fish populations.

In nature fish interact in a complex way with water, stones, and trees, and rivers with little regard for jurisdictional boundaries. Yet in our research and management agencies the offices and activities of fisheries personnel, hydrologists, and foresters are poorly integrated. Until the structure of research and management institutions approaches the level of integration and scale of the natural ecosystems with which they deal, attempts at restoration and preservation will remain piecemeal and ineffective. Only a shift in management perspective from the site-specific to an interdisciplinary watershed-level

approach based upon scientific principles will substantively address the goals of watershed and fish population health. This integration of disciplines is inherent in an ecosystem perspective.

The scale of the degradation of the region's watersheds and fish habitat, exceeds the ability of our public institutions to respond. Unfortunately, site specific or system component-level management (e.g., fish, wildlife, timber production) supercedes integrated watershed needs. Naiman (1992) proposes the following essential conditions for implementing new approaches to watershed management:

1. Cooperation between industry, governmental agencies, private institutions, and academic organizations.

2. Technical solutions (e.g. hatcheries, silviculture) must be augmented with increased habitat protection and preservation of fundamental components of long-term watershed vitality (e.g., riparian forests).

3. Information management and scope of experimental manipulations needed should involve multiple institutions, demonstration and reference sites, and continuity over many years.

4. Conceptual solutions to resource management(e.g., perceptions, tradition) at the expense of empirically grounded, data-driven decisions must be reversed.

5. Integration of human activities as a key element of ecosystem vitality. Human needs must be integrated with environmental considerations before long-term sustainability of our watersheds can be achieved.

Additional statutory and administrative barriers that must be overcome to change existing river management regimes include:

1. The lack of inter-agency infrastructure in the Pacific Northwest necessary for watershed management.

2. Failure to implement existing wetland and forest practice regulations. This is a result of poor staffing and inadequate training of personnel. Furthermore, quality control reviews of regulatory program effectiveness do not exist. Analyses of specific land use management regimes (e.g., riparian forest practices) should be conducted to assess whether they are working as intended. Also, we must first consistently enforce existing regulations (e.g. forest practices within wetland riparian forests) before new watershed regulatory structures are implemented.

3. Lack of technically trained staff in local, state and federal agencies in the Pacific Northwest able to implement a watershed level management plan.

Potential social, economic, and political barriers to watershed restoration and management include:

1. Hydroelectric power industry water diversion projects.

2. Timber industry - ecologically appropriate riparian forest regulations will restrict timber revenues.

3. Agricultural interests - restrictions of water diversion to agricultural lands.

3. Floodplain development - ecologically appropriate restrictions of development within river floodplains.

4. Tax laws - use of tax revenues to fund a watershed initiative.

5. Private stewardship of watersheds.

IV Restoration and Maintenance of High Quality Watershed Health - Sustainability of Harvestable Naturally Spawning Fish Populations - Management Techniques and Directives.

To be successful watershed restoration must restablish:

1) The watershed's natural hydrologic and disturbance regimes;

2) The historic physical linkages between streams and their associated floodplains and wetlands;

3) The riparian forest and other riparian plant communities.

Present and historic fish habitat management approaches focus primarily upon the site-specific establishment of in-stream structures to create habitat elements such as pools and riffles (e.g. cabled logs, in-stream boulders), and the reestablishment of stream temperature control through riparian reforestation. Though sometimes effective in the short term, the in-stream structure approach is neither a long term solution, nor cost-effective (i.e. the cost of in-stream structure placement throughout a watershed would be prohibitive). This approach is inadequate to achieve the goal of restoring and maintaining natural levels of physical and biological complexity in a stream ecosystem (Bisson et al. 1992). Watershed restoration goals need to be set within a long term context of many decades (>50 yrs) and should include the entire watershed from headwater streams to

estuarine tidal marshes. *Only at spatial and temporal scales of these magnitudes do the watershed hydrologic patterns, natural disturbances, and riparian forests become meaningful in the discussion of the restoration and management of naturally spawning fish populations.* To accomplish watershed restoration a major shift in philosophy, assumptions, and strategies toward fish habitat restoration and management is necessary (Frissell 1992). The restoration of streams and riparian zones throughout a watershed is a formidable task requiring an unprecedented level of cooperation and willingness to alter current land use practices (Gregory et al. 1991, Sedell and Beschta 1991, Bisson et al. 1992).

At present, there are no watershed-level restoration models applicable to the Pacific Northwest. However, river and watershed restoration approaches are beginning to emerge that focus upon reestablishing the key components of an ecologically healthy watershed (Sedell et al. 1990, Sedell and Beschta 1991, Frissell 1992).

We have many of the technologies necessary to restore forested watersheds in the Pacific Northwest (e.g., horticultural, silvicultural, engineering, geologic, and hydrologic techniques). What we lack is the breadth of vision and cooperation necessary to apply these technologies appropriately in a context of watershed restoration and management. An ecosystems approach to watershed restoration and management will incorporate fundamental watershed physical processes and the natural biologic diversity of the landscape. For example, studies of the recovery of aquatic systems from natural disturbances have revealed the occurence of refugia, undisturbed habitats that function as a source of colonists to adjacent disturbed areas (Sedell et al. 1990, Frissell 1992). The ecologic properties of refugia throughout watersheds will be critical in the restoration of degrated rivers and streams.

None the less, we lack restoration projects that are based upon the restoration of watershed ecosystem processes. Restoration at this scale is our only real hope for sustaining harvestable naturally-spawning fish populations. To accomplish this will take unprecedented cooperation between public agencies, regional universities, Indian Tribes, and private industry.

We propose the development of a Pacific Northwest Regional Initiative for Watershed Studies, Restoration, and Management. The goal of the initiative would be the development of solutions to our region's watershed problems. The scope of the issue is beyond the ability of a single state government or federal agency to solve. We suggest an initiative open to all federal and state agencies, regional universities, Indian Tribes, and private industry. Staff would include policy makers, economists, social scientists, and natural and physical scientists from across local, state, and federal agencies, regional universities, Indian Tribes, and private industry. The task would be to develop solutions to regional as well as watershed level problems. Components of such an initiative would include:

1. Basic research into watershed science.

2. Establishment of a representative array of watershed reference sites throughout the Pacific Northwest.

3. Establishment of watershed restoration projects as demonstration sites for research and training.

4. Development of training programs for future professional watershed stewards.

5. Emphasis on watershed and regional consensus process.

6. Watershed restoration and management technical and policy information transfer.

7. New approaches to commodities extraction (e.g. riparian silviculture).

V The Economic Benefits of Managing Rivers on a Ecosystem Basis - Compared to the Existing Piecemeal Approach

Restoration and management of rivers and watersheds on an ecosystem basis is the only approach that will insure the sustainability of healthy native fish populations and watershed health, ocean harvesting levels not with standing. Without the active implementation of a region-wide watershed restoration initiative throughout the Pacific Northwest, potentially hundreds of native salmon stocks will go extinct bringing on a collapse of the regional fishing industry (Nehlsen et al. 1991). Concerning this crisis, proactive measures will save a significant part of our regional economy. Regional economic benefits resulting from ecosystem management of rivers and streams include:

1. Sustainable harvest of native fish populations.

2. Development of a sustainable riparian silviculture.

3. Reduced litigation and downstream mitigation and clean-up.

4. Development of specialty tree crops for pulp and fiber (e.g. poplar trees).

5. The export nationaly and globally of watershed restoration and management expertise and techniques.

6. Improvement of human health through recreation.

7. A sustained ecological tourism industry.

CONCLUSION

If we do not act now we will we stand to lose much of what makes the Pacific Northwest unique. We will lose a significant aspect of our region's sustainable economy. The Pacific Northwest salmon are an indicator of our regional watershed health. Their loss will surely be followed by a number of other less visible riverine and riparian organisms. If we do not act we will be mandated to action as a society by provisions of the Endangered Species Act. Salmon species will be listed as endangered and recovery plans will be developed and implemented to recover and restore their critical habitat. We can either go forward with a proactive plan or wait and find ourselves facing a more significant crisis. We will end with the loss of species, loss of jobs, and a loss to future generations.

We do not have adequate scientific or management infrastructures to deal with the scale of the crisis at hand. We need a new interdisciplinary, inter-agency and inter-university regional initiative where watershed-level issues can be defined and solved. New professional resource stewards need to be trained. We have the collective expertise in our universities, local, state, and federal agencies, Indian Tribes, private industry, local, and state governments necessary to pursue a regional watershed effort.

Our watersheds, if provided with adequate protection and nurture, will supply us with many ecological services into the future. We can leave our children a regional legacy of ecological health based upon ecosystem restoration and the sustainable use of our rivers, streams and watersheds. Finally, understanding and integrating human activities into the watershed management process must be achieved if the region is to attain any form of sustainability (Ruckelshaus 1989, Naiman 1992).

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TESTIMONY OF DR. JAMES R. KARR, DIRECTOR
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BEFORE THE COMMITTEE ON MERCHANT MARINE AND FISHERIES
and
SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES

MARCH 9, 1993

Thank you, Mr. Chairman, for inviting me to appear before this committee to comment on the status of watersheds in the Pacific Northwest and solutions to restore them, including naturally spawning salmon populations.

1. What is your assessment of the condition of river systems in the Pacific Northwest under the present management regime?

Like rivers throughout North America, the rivers of the Northwest have been decimated in the last century. The magnitude of degradation in river resources eclipses that of other resources that have received far more attention (e.g., wetlands). That degradation is manifest in alteration and destruction of stream channels, alteration of river flow patterns, species endangerment and extinction, introduction of contaminants, declines in commercial- and sport-fishery harvests, consumption advisories due to contamination of fish and shellfish, and degradation of the aesthetic values of those river systems. An abundance of clean, productive streams and riparian corridors has been reduced to vestiges. Appendix I provides more detail on these points with quantitative information and citations (Appendix II) for the Northwest and nationally.

Although continuing degradation of aquatic systems is obvious, even to the untrained eye, concern by government agencies has been weak, inappropriately focussed, and largely ineffective at reversing resource declines. Failure to reverse the trend of aquatic degradation is unacceptable on legal, scientific, economic, and ethical grounds.

2a. What are the essential attributes of healthy watersheds and fish habitat?

A watershed "can be considered healthy when its inherent potential is realized, its condition is stable, its capacity for self-repair when perturbed is preserved, and minimal external support for management is needed" (Karr et al. 1986). By any of these criteria the watersheds of the Northwest cannot be considered healthy. Over 97% of the naturally spawning salmon runs of the Columbia River have been lost. Further, and perhaps of greater relevance, 100% of the production of major areas of the Columbia River watershed have been lost. The situation is similar for salmon, trout, and steelhead throughout the region. How would we respond as a society if our agricultural productivity declined by over 90%?

All watersheds cannot be preserved in pristine condition. But we can and should seek to protect rivers and their watersheds from the more egregious

influences of human society. Special attention should be paid to protecting the interests of individuals alive today (intragenerational equity) and future generations (intergenerational equity).

The ability to sustain a healthy biological community is one of the best indicators of the potential for beneficial use (broadly defined) of a water resource. Support of healthy assemblages of aquatic organisms requires the proper quantity and quality of water, a stream channel in relative equilibrium with its watershed (supply of water and sediment, geological substrate, and vegetation cover, etc.), riparian vegetation that buffers the impact of terrestrial environments, and land use with minimum negative impact on riparian and stream channel environments.

In their natural state, watersheds contain an interactive mosaic of environments that extend from headwater streams and wet meadows at the upper limit of drainage basins to the ocean. This mosaic includes small streams and large rivers, riparian zones, the terrestrial watershed, groundwater (including the hyporheic zone), and near coastal and estuarine areas. All are integral components of watersheds capable of supporting viable salmonid populations.

Individual humans actions within the watershed may produce small effects, but when these impacts are combined, they spawn more complex problems that cascade across the landscape and down the river, resulting in considerable loss of natural resource values. The cumulative affect is often ignored because most conventional aquatic resource evaluations consider only local water quality parameters.

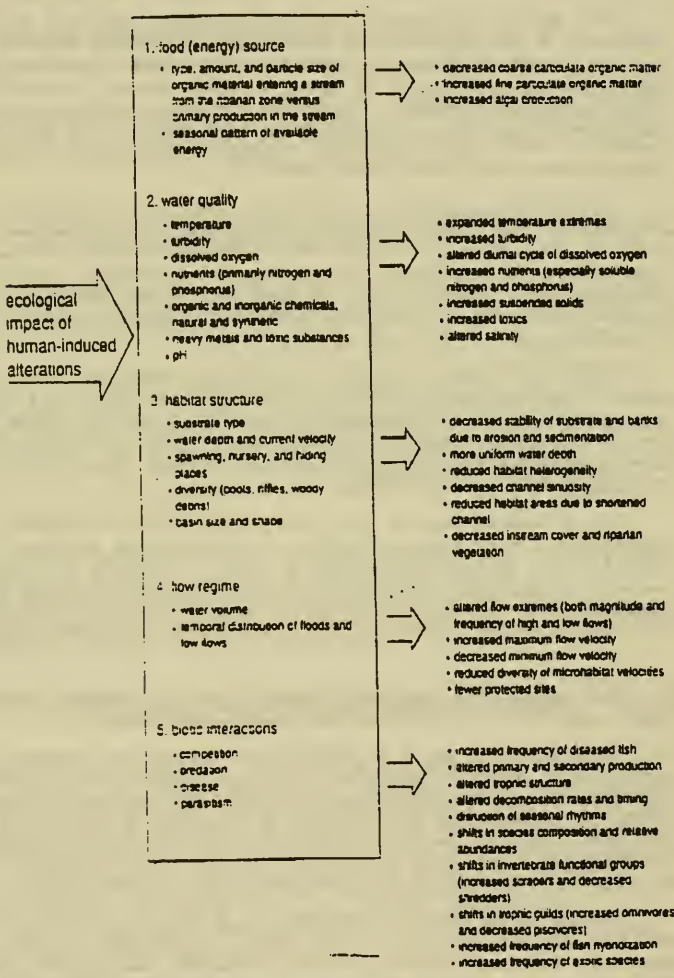
Human actions degrade water resources by their influence on five components of river systems (Table 1). Examples from Northwest watersheds are given for each of the five factors in Table 2. Efforts to protect the aquatic resources of Northwest watersheds are doomed to failure unless they explicitly incorporate knowledge of these factors into a comprehensive planning process that integrates the influences of local and regional human actions.

2b. What is the role that riparian areas play in promoting "ecosystem health," as well as providing high quality fish habitat?

Riparian areas serve as buffer zones between the terrestrial and aquatic components of regional landscapes (Karr and Schlosser 1978). Thus, riparian corridors are an important first line of defense because they have the capability of mediating the influence of landscape alteration on river resources. But the cumulative effect of activities in upland areas can overwhelm the effectiveness of riparian buffer strips. Thus, riparian strips should not be oversold as cures for depressed fish populations.

Beware of the quick fix!! Clean water, flood control and hatcheries have been the rallying cries of the past, but they have failed to protect the resource. Habitat, riparian corridor protection, barging of juvenile salmon, and bounties on squawfish are today's rallying cries. Most are important tools in the restoration arsenal but none is adequate.

Table 1. Five major classes of environmental factors that affect aquatic biota. Arrows indicate the kinds of effects that can be expected from human activities (From Karr 1991).



FROM:

BIOLOGICAL INTEGRITY: A LONG-NEGLECTED ASPECT OF WATER RESOURCE MANAGEMENT[1]

JAMES R. KARR

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Table 2. Examples of influences on each factor representative of problems in Northwest watersheds.

FACTOR	TYPICAL DEGRADATION IN NORTHWEST WATERSHEDS
Food (energy) source	Supply of organic material from riparian corridor altered Nutrients from the carcasses of adult salmon after spawning reduced or not available
Water Quality	Elevated temperatures Oxygen depletion Chemical contaminants
Habitat Structure	Sedimentation and loss of spawning gravels Obstructions that interfere with movement of adult or juvenile salmonids Lack of coarse woody debris Destruction of riparian vegetation and overhanging banks Lack of deep pools Altered abundance and distribution of constrained and unconstrained channel reaches
Flow Regime	Altered flows that limit survival rates during any phase of the salmon life cycle
Biotic Interactions	Increased predation on young by native or exotic species Overharvest by sport or commercial fishers

These examples of best management practices are much like the best management practices defined by soil conservationists to protect soil resources. But like soil conservation BMPs, application of watershed planning processes requires replacement of the current fragmented approach to BMP use with development of integrative Best Management Systems (Karr and Schlosser 1978). The legacy of narrow planning programs can be seen in fish ladders and hatcheries, solutions that developed to correct symptoms rather than problems. Like other BMP's, riparian corridors must be integrated into a watershed-level best management system. Only by integrating the planning process across landscapes can we protect river systems.

3a. Are existing management regimes on state, federal, and private land adequate to prevent further degradation of watersheds and fish habitat?

NO! The decline in water resource quality, salmonids populations, and Northwest watersheds continues because existing programs and the way they are implemented are not adequate. The goal of the Clean Water Act, to "restore and maintain the physical, chemical, and biological integrity of the Nation's

waters" is adequate but that goal is not clearly established by the implementing regulations and policies of the agencies responsible for enforcing the Act. For years the Clean Water Act has been implemented as if crystal clear distilled water flowing down concrete channels is the goal of the Act.

The Endangered Species Act is inadequate because, although it provides an emergency room for treatment of patients (listed species), it does not provide a hospital or a preventative care program that prevents the need to list and the listing process fosters legal impasses and extreme social dislocations. The National Forest Management Act of 1976 states that "management prescriptions...preserve and enhance the diversity of plant and animal communities," a goal that is attained by few forest plans.

Most past government programs have concentrated narrowly on issues such as prevention of chemical contamination (pollution), flood control, construction of fish ladders for adult passage, or harvest of wood. Often those programs have stimulated resource degradation due to secondary influences or because they did not address all factors responsible for degradation.

Rather than programs designed to maintain the natural regeneration capacity of these systems, we tried to substitute expensive, and usually unsuccessful, technological fixes. Indeed, technological fixes often contributed to the problem. Finally, current management programs require increasing amounts of societal energies and scarce funds to protect what remains and have little chance of success.

3b. If not, are there any statutory or administrative barriers that would hinder changes in the management regime for rivers?

YES! Current statutory programs and administrative structures are too fragmented to allow anything but a piecemeal approach to the protection of water resources. Statutes narrowly focus on individual problems such as endangered species, soil erosion or water quality. For the past two decades, wetlands have been the focus of major attention while rivers have been degraded by numerous human actions. Increased attention to old-growth forest has not adequately incorporated the water resource impact of forest alteration. Each habitat, species group (e.g. marine mammals), or resource (soil, water) is treated independently in different legislative initiatives and responsibilities are fragmented among agencies despite the broad connections among these resources and the values they provide for human society. Incentives for agencies to work in an integrative fashion at the watershed level are nonexistent.

One can conceive of legislation such as a Top of the Mountain Act or Bottom of the Lake Act as we attempt to protect all environments important to human society. Rather, we need a broad societal policy that protects ecological integrity or health, and avoids biotic impoverishment, the progressive erosion of Earth's capacity to sustain living systems, including human society (Woodwell 1990, Angermeier and Karr in review).

3c. In addition, are there other barriers (economic, social, or political) that might also create problems?

Perhaps the most important barrier is the lack of a societal literacy about the connections among resource systems and the dependence of human society on those resources. As a result, we act as if our ability to alter carrying capacity through technological innovation is unlimited. But we are subject to many constraints because, although our culture and technology changes rapidly, we are still dependent upon slowly changing ecological systems. New policy goals and management objectives that clearly integrate biological, social, cultural, and economic perspectives are needed.

The current predicament is to a large extent a by-product of the growth of economic models that Herman Daly (1991) characterizes as "boundless bull." Economics is an abstract science that, in its most common form, distorts the relationship between the economy, society and natural resources (Daly and Cobb 1989, Costanza 1991, Karr 1993). In reality, the human economy is supported by an array of services supplied free by natural systems. Thus, the concept of value must be extended beyond what "can be computed simply in terms of consumptive preferences" (Haskell et al. 1992). The failure to recognize the dependence of the economy (the frosting on a layer cake) on a healthy society and a natural resource base (the upper and lower layers of the cake) is best illustrated by the simplistic but often cited environment vs. economy dichotomy.

4. What management techniques are available to maintain and restore high quality watersheds that will sustain harvestable, naturally spawning fish populations?

An organized program is needed to restore these vital ecological systems to prevent extinctions, declines in valued resources (including consumptive and nonconsumptive use of those resources), and an emerging water crisis (including water rationing in Seattle last year!!).

Comprehensive watershed-level, restoration programs should involve a five-step process:

1) Identify resource condition (status and trends);
2) Identify the components of ecological health or integrity that have been degraded;
3) Identify the human action(s) responsible for the degradation;
4) Establish a watershed-level plan to reverse the degradation; and
5) Evaluate the success of protection and restoration programs.

The final step should involve direct assessment (step 1) of the condition of valued biological resources (e.g., salmon) to determine if program goals are being accomplished. The importance of avoiding sole dependence on use of water quality parameters or "habitat quality" as surrogates of biological integrity or status of salmon populations cannot be overemphasized. Special care should be exercised to insure that success is

not measured in terms such as number of construction projects, permits issued, or hatchery fish released. Procedures developed in recent years to protect the biological integrity of water resources (Karr et al. 1986, Lyons 1992, Kerans and Karr in review) provide easily used and ecological sophisticated approaches to assess resource condition. Biotic integrity assessment can easily be integrated with watershed-level planning at diverse spatial scales.

The principles required to plan protection and restoration programs are similar across watersheds. But, because human influences and natural conditions vary among watersheds, watershed specific evaluations must be undertaken to determine the cause of degradation. Then and only then, can plans be developed to correct local problems. General solutions (such as release of hatchery fish or habitat reconstruction) are not appropriate in the absence of careful problem assessment. Past approaches were often ill-conceived because planners proposed solutions as if ecosystem dysfunction could be reversed without broad understanding of those systems. Successful approaches should be based on a broad planning perspective and a planning effort based on evaluation of local ecological, social and economic conditions. The management techniques have been available for years but they have not been used in an integrative way.

The window of opportunity to reverse this decades-long trend in declining water resources and salmon populations is closing because of the extent of loss of watershed processes upon which those salmon depend and, thus, the salmon themselves. This decline can only be reversed by substantive change in our actions and in the conceptual framework used to define those actions. Immediate short-term actions are essential to provide the opportunity for long-term restoration programs. These actions include:

1. Identification and protection of existing high quality sites, sites with healthy biological communities. Recent scientific workshops have concluded that immediate actions must be taken to preserve the few healthy watershed refuges that remain in the region. Those refuges hold most of the spawning and rearing habitat for salmon. Quick action is needed to identify and protect those areas to safeguard existing salmon runs and provide viable populations that can recolonize additional areas to be restored.

2. Stabilize roads and other erosive or otherwise unstable areas in and near these protected areas

3. Move to restore nearby degraded reaches, taking advantage of the protected refuges as sources of colonists

These mostly local scale activities must be integrated with watershed level planning that produces Best Management Systems for regional landscapes. The cost of these efforts will not be high relative to the benefits to society. Environmental benefits include improved water resource quality, continued vitality of forest and river systems, protection of soil resources, more conservation minded uses of water, and protection of the aesthetic quality of the Northwest environment.

5. Are there economic benefits to managing rivers on an ecosystem basis, compared to our current piecemeal approach?

Economic benefits will accrue from improving the effectiveness of programs to protect water resources. Jobs lost in the salmon fishing and tourism industries will be restored; jobs will be created and the economic base and social structure of rural communities will be preserved. Water supplies (both quantity and quality) will be protected for agricultural and urban uses. Dredging of rivers and harbors will be reduced as the amount of sediment transported to rivers declines.

The Northwest has an opportunity to avert a disaster that has befallen the Midwest. The pursuit of maximum yield and agricultural profit in that region has had catastrophic effects on the social fabric of agricultural communities. We should work now to avoid further economic and social dislocation in the Northwest due to overharvest of natural resources and a lack of attention to the fabric of society.

CONCLUSIONS

Rivers are in many ways the lifeblood of human society. They provide water for domestic and industrial uses, they serve as transportation corridors, they provide food, recreation and scenic beauty. In addition to their direct importance to human society, their status is indicative of the health of the surrounding landscape in the same way that blood samples provide important insight about the health of humans.

Our future depends on our ability to create positive, long-lasting solutions. The two most important components of that effort will be 1) protection and restoration of natural resource systems and 2) diversification of the regional economic base. We can no longer exploit and alter the landscape as if it is infinitely resilient to human actions.

An initiative that combines a watershed planning perspective with a watershed restoration initiative provides the central organizing principles that are fundamental to long-term success. Water's mobility, integrative qualities, and importance to all biological systems makes examination of the status of water resources a practical approach for assessing the condition of the landscapes upon which humans depend for their long-term "health."

APPENDIX 1 - TESTIMONY OF JAMES R. KARR MARCH 9, 1993

TABLE 1. EXAMPLES TO ILLUSTRATE THE STATUS OF U.S. RIVERS AND THEIR FLOODPLAINS

¶ Of 3.2 million miles of rivers in the continental United States, only 2% are healthy enough to be considered high quality and worthy of protection (Benke 1990).

¶ Only one large river (greater than 600 miles long), the Yellowstone, has not been severely altered.

¶ Of medium sized rivers (between 120 and 600 miles long), only 42 studied in the National Rivers Inventory have not been dammed.

¶ 60-80% of riparian corridors have been destroyed throughout the U. S. (Swift 1984)

¶ Over 70% of the original floodplain forests in the U. S. has been converted to urban and agricultural use (Hunt 1988).

TABLE 2. EXAMPLES TO ILLUSTRATE THE STATUS AND TRENDS IN THE AQUATIC BIOTA OF THE UNITED STATES, WITH SPECIAL EMPHASIS ON RIVERS.

¶ A larger proportion of aquatic organisms is classed as rare to extinct (34% of fish, 75% of unionid mussels, and 65% of crayfish) than is true for terrestrial organisms (birds, mammals and reptiles from 11 to 14% - Master 1990).

¶ 20% of native fishes of western U. S. are extinct or endangered (Miller et al. 1989).

¶ 32% of Colorado River native fish are extinct, endangered or threatened (Carlson and Muth 1989).

¶ In the Pacific Northwest, 214 native, naturally spawning Pacific salmon and steelhead stocks face "a high or moderate risk of extinction, or are of special concern" (Nehlsen et al. 1991).

¶ Since 1910, naturally spawning salmon runs in the Columbia river have declined by over 95% (Ebel et al. 1989).

¶ During this century, the commercial fish harvests of major U. S. rivers have declined by over 80% (Missouri and Delaware Rivers), over 95% (Columbia River), and 100% (Illinois River) -- see Hesse et al. 1989, Patrick 1992, Ebel et al. 1989, and Karr et al. 1985).

¶ In 1910, over 2,600 commercial mussel fishermen operated on the Illinois River while virtually none remain today.

¶ Since 1850, many fish species have declined or disappeared from rivers in the United States (Maumee River, Ohio - 45%, Illinois River, Illinois 67% - Karr et al. 1985; California rivers 67% - Moyle and Williams 1990). That combined with the introduction of exotics has homogenized the aquatic biota of many regions (An average of 28% of the fish species in major drainages of Virginia are introduced - Jenkins and Burkhead in press).

¶ Since 1933, 20% of molluscs in the Tennessee River system have been lost (Williams et al. 1989). 46% of remaining molluscs are endangered or seriously depleted throughout their range (Jenkinson 1981).

¶ 38 states reported fish consumption closures, restrictions, or advisories in 1985 (Moyer 1986). 47 states in 1992. Contaminated fish pose a health threat to wildlife and people (Colborn et al. 1990, Cunningham et al. 1990). That threat includes intergenerational consequences such as impaired cognitive functioning in infants born to women who consume contaminated fish (Jacobson et al. 1990).

APPENDIX II - TESTIMONY OF JAMES R. KARR MARCH 9, 1999

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March 1, 1993

Honorable Gerry E. Studds
Chairman, Merchant Marine and Fisheries Committee
U.S. House of Representatives
Room 1334, Longworth House Office Building
Washington D.C. 20515-6230

Dear Mr. Studds,

It is an honor and a privilege to address your committee on the status of Pacific salmon stocks in northwestern California and how taking an ecosystem approach to river management might help to restore them. My comments are offered as those of the Humboldt Chapter of the American Fisheries Society for which I served as principal author of Factors Threatening Northern California Stocks With Extinction (Higgins et al. 1992). This work characterized the risk of stock extinctions of chinook salmon, coho salmon, steelhead and coastal cutthroat trout in rivers from the Russian River north to the Oregon border, including the Klamath and Trinity Rivers and their tributaries. I also rely on my experience as a consulting fisheries biologist in helping to write the Long Range Plan for the Klamath River Basin Fisheries Conservation Area (USFWS 1991). This plan takes a watershed approach to preserving biodiversity and guides your $40 million, twenty year effort to restore anadromous fisheries to that river (Higgins and Kier 1992). I will offer comments only on river systems for which I have direct knowledge. The text will be in response questions that I received in preparation for my testimony on March 9, 1993 before your committee.

1) *What is your assessment of the condition of the river systems in the Pacific Northwest under the present management regime?*

In my work for the U.S. Fish and Wildlife Service (1991) on the Klamath River, I characterized it as "severely ecologically stressed." The lower river has been filled in by 20-30 feet of sediment, flows have been reduced by dams which decreases the river's ability to flush itself, and river temperatures in late summer exceed 75 degree F. The source of the river in southern Oregon is Upper Klamath Lake which has deteriorated to the point that it has experienced massive fish kills and some of its endemic fish fauna are going extinct. The South Fork of the Trinity River is the largest Wild and Scenic River basin in California without a dam, yet it is in a similar condition to the Klamath. Chronic problems with high sediment delivery keep riparian zones from recovering, inhibit production of invertebrates which reduces available food for juvenile salmonids, and result in unstable spawning gravels. Maximum summer water temperatures in the lower South Fork Trinity in 1991 reached 81 degrees F, which is lethal for salmonids.

All other major river systems in our area, with the exception of the Smith River, have similar problems to those described above. The Eel River is the fourth largest salmon and steelhead producer in California, but there is some prospect that these species may be lost from the river. Erosion problems in the Eel watershed are immense, with an estimated 60 feet of material deposited over the old river bed from past flood events. According to U.S. Fish and Wildlife Service reports, the main stem of the Eel River as recently as 1959 could support 140,000 pairs of spawning salmon but today the main stem of the river is no longer suitable for spawning. The river relied primarily on its healthy tributaries to support anadromous fish after past floods, but those have recently been severely damaged by logging.

All smaller coastal river basins in the region have had similar problems with sedimentation due to extremely unstable geologic conditions in our region coupled with disturbances related to industrial timber practices. The high sediment load of almost all northwestern California Rivers has caused estuaries to fill. The estuary of the Eel River for example has shrunk by over 50 percent since 1950 (Higgins 1991). These important habitats serve as nursery areas for salmonid juveniles, such as chinook salmon, and marine species such as Dungeness crab.

The ecological changes in the rivers of our region result in conditions under which introduced exotic, warm water fish species may thrive. Green sunfish were found to be successfully reproducing in the South Fork of the Trinity River during the recent, prolonged drought. There is some evidence that these fish are predating upon juvenile steelhead. Sacramento squawfish were introduced to the Eel River a decade ago and have since spread throughout the entire river basin. These fish are predacious and have experienced almost an exponential cycle of growth. Plunging salmon and steelhead populations in areas of the basin first colonized by squawfish suggest that they have had a devastating impact.

In areas further south or in interior river basins, impacts may come largely from agricultural activities. The Shasta River, which has always been a substantial contributor to Klamath chinook salmon production, is now almost unsuitable for these fish. Lack of riparian cover and depletion of flows for irrigation have caused the river to rise to 90 degrees F in summer. Lack of riparian fencing also allows livestock direct access to the river resulting in excessive nutrient loading. Dissolved oxygen in summer has been measured at 2.4 ppm, which is lethal to salmonids. The Russian River to the south has a complex set of problems related to flow depletion for farming and vineyards, sub-urban development, and excessive gravel extraction.

2) *What are the essential attributes of healthy watersheds and fish habitat? What is role that riparian areas play in promoting "ecosystem health" as well as providing high quality fish habitat?*

Since I will be addressing your committee with such scholars as Dr. James Sedell, I will only offer my assessment of what healthy watersheds remain in my region. Those rivers that flow from Wilderness or Roadless Areas on U.S. Forest Service lands such as Smith River, Wooley Creek, Dillon Creek, Clear Creek, upper Blue Creek, lower Hayfork Creek, New River, and the North Fork of the Trinity River are the only systems that possess high quality fish habitat at this time. The attributes that all these watersheds share are: no or few roads or if they are roaded then roads are well designed, diverse vegetative cover including lots of older age conifers, sufficient large woody debris adjacent to streams to provide for natural recruitment, and the absence of large numbers of livestock or heavy mining activity.

I am sure that the role of healthy riparian zones in forested lands will also be covered by the testimony of Dr. Sedell, but I would like to make sure that such attributes are not overlooked on streams through alluvial valleys, such as the Shasta River. Undercut banks beneath root masses of riparian trees provide the best fish habitat in these valley streams which were once the most productive of fish habitats. Stream side trees provide shade to these rivers, moderating stream temperatures, and prevent bank erosion which preserves valuable agricultural land. Open access for cattle to stream side areas for over 100 years has destroyed riparian vegetation. This often leads to down-cutting of streams which can result in a drop in the local water table and a reduction in the productivity of the land.

3) *Are existing management regimes on state, federal, and private land adequate to prevent further degradation of watersheds and fish habitat? If not, are there statutory or administrative barriers that would hinder changes in management regimes for rivers? Are there other barriers (economic, social, or political) that might also create problems?*

Current management regimes have almost completely failed to prevent watershed and stream degradation and further damage is likely without fundamental change. Some barriers to sound management require administrative changes while others necessitate legislative action.

Public Forest Lands: While the U.S. Forest Service has shown increasing recognition of the problems leading to decline of fisheries resources, implementation of meaningful change to prevent future damage varies from one forest to another. Six Rivers National Forest has been under scrutiny by an active environmental community and has therefore implemented some very progressive policies with regard to timber harvest on erodible terrain. Adjacent forests, where local communities were primarily interested in timber extraction, have shown less sensitivity in the past to fisheries and wildlife issues.

All National Forests have been caught in the conflict of "getting the cut out" to generate revenue, knowing that the last

patches of merchantable timber are on increasingly steep and unstable ground. Past practices have lead to over-cutting which means that a period of light timber extraction and re-investment in the productivity of the land must begin. The USFS must move away from token fisheries projects such as channel manipulations and move toward a more sound ecological approach. The primary barrier to better management on USFS lands seem to be administrative but the fundamental changes needed may be difficult without major changes in staff. Specific legislative protection of the best Pacific salmon refugia is necessary at this time, however.

Private Forest Lands: Current logging practices on private land in California completely ignore concerns for cumulative effects. Recent disturbances on private timber lands have set the stage for substantial degradation to stream habitats which will be triggered by the next major storm event. While Six Rivers National Forest has withdrawn all its lands from timber harvest in Grouse Creek (South Fork of the Trinity), all timber harvest plans on private land continue to be approved. Some watersheds with unstable geologic conditions have experienced disturbance levels from 60-80 percent in a decade despite warnings from scientists of extreme risk of soil loss associated with such practices.

The California Department of Forestry has allowed clear cut timber harvesting in steep, inner gorge areas that pose greatest risk of sedimentation to stream channels. Large coniferous trees are often removed from riparian zones when steep slopes or deciduous trees provide shade to streams; only stream temperature was considered when current rules were formulated. Humboldt AFS has appraised the California Board of Forestry, both at hearings and in writing, about the potential loss of stocks of salmon in streams effected by industrial timber practices. Our requests that watersheds harboring stocks at risk be designated as Sensitive Watersheds under Forest Practices Rules have received no response. Other aquatic species in our region, such as tailed frogs (Asclepius truei) and Olympic salamanders (Rhyacotriton olympicus) are also at risk of extinction but CDF has no plan to protect them.

California Forest Practices Rules have failed several times over the course of a decade to be approved as Best Management Practices under the Clean Water Act. Currently, the EPA delegates authority over control of non-point source pollution to the California State Water Resources Control Board. Humboldt AFS additions of streams impacted by non-point source pollution to the list of impaired water bodies in 1988 showed that the system of delegation is not working. The SWRCB failed to include many of these water bodies in their data base without justification but the EPA then forced them to reconsider. Most of the streams were ultimately included. It seems that a stronger, direct enforcement role for the U.S. Environmental Protection Agency in oversight of timber harvest should be considered during the re-authorization of the Clean Water Act.

Private Agricultural Lands: Stream degradation due to agricultural practices and flow depletion have both administrative and statutory barriers. The California State Water Resources Control Board has the authority to prevent water users from wasting water but actions are only initiated when a complaint is filed. Any riparian land owner in California may begin to extract water without any permit from the SWRCB at any time. This antiquated water law needs revision if we are to maintain fisheries resources in the face of increasing development in the state. Ground water extraction is almost completely unregulated in the state, yet if aquifers are drawn down, streams may dry up and riparian zones may die. I am unaware of any statutes that prevent over-grazing that leads to stream degradation due to loss of riparian vegetation. Non-point source pollution from stock may be a violation of the Clean Water Act but no enforcement action has been initiated in our area.

There is a misperception at present in rural communities that private property rights reign supreme over public trust resources. These local interests groups see only short term economic gains or losses and are reluctant to entertain more sustainable land use practices. Thinking people, however, are recognizing that we must change. A major economic engine for over-cutting of our forests is an almost unlimited international market for wood products. In the past, when markets were primarily domestic, recessions led to decreased demand for wood products and a slow down in the rate of logging on public and private land. Free market economics can no longer be relied upon as a moderating influence on forest harvest.

4) *What management techniques are available to maintain and restore high quality watersheds that will sustain harvestable, naturally spawning fish populations?*

I support the watershed approach to fisheries and river restoration currently being advanced by Mr. Robert Doppelt of Pacific Rivers Council, who joins me on this panel. A similar approach is endorsed in the Klamath Plan (USFWS 1991). The most cost effective method of restoring streams impacted by sedimentation is to stabilize upland areas and allow streams to flush during subsequent high flows. While implementation of such a strategy should move forward on public lands immediately, there is a great need for similar activities on private lands as well. No public money should be spent on private lands, however, until there is fundamental reform of timber harvest practices.

Because the landscape is so fragmented at this point and rivers in such bad ecological health, I believe it is prudent to place the watersheds which serve as refugia for the last viable Pacific salmon populations in permanent reserves. No restoration will be possible in the future if the last gene resources that exist in lightly impacted or undisturbed watersheds are lost. We must also develop long term strategies based on desired future conditions of riparian areas so that stream health can be restored.

Widespread implementation of water conservation measures is needed throughout California. Leaky irrigation ditches, often in use since before the turn of the century, lead to a tremendous waste of water. If efficiency of water use were increased by implementation of water conservation measures, we could maintain agricultural productivity and regain public trust resources such as fish and water quality. Riparian restoration in agricultural lands is essential if we are to restore salmon and steelhead. Although many times fish are spawned and rear in steep areas above alluvial valleys, they must successfully migrate through these valley reaches if they are to complete their life cycle. Restoring riparian zones only requires cattle exclosures and tree planting. Federal programs should be made available to farmers and ranchers who willingly participate in such programs.

The marshes surrounding Upper Klamath Lake must be restored if we are to reverse the condition of the lake and prevent the extinction of its fishes. If water quality problems in the lake are not reversed, the entire Klamath River restoration program is jeopardized. Water conservation measures and riparian restoration on tributaries feeding the lake also must be implemented.

I am currently helping to put together a model program for the Klamath River basin, using the EPA Reach File, to make information on fisheries and water quality readily available to professionals as well as the interested public. When the Klamath EPA Reach file is complete, fisheries biologists from any agency will be able to access information in minutes before consultations on a land use project that now takes several hours or several days of research. Agencies or individuals will be able to access information on the history and problems in a watershed to better understand potential impacts of a project they are proposing. To succeed in restoring the ecological health of all our water bodies, we must begin to take a more systematic approach to managing and sharing information.

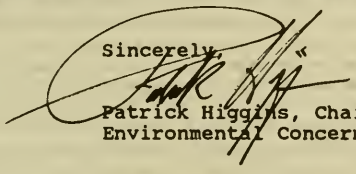
5) *Are there economic benefits to managing rivers on an ecosystem basis, compared to our current piecemeal approach?*

It is difficult to gauge the worth of preserving self-perpetuating salmon, steelhead and trout stocks. When these fish return to healthy watersheds, they reproduce at no cost to the public. Estimates by the Pacific Fisheries Management Council in 1983 showed that 1,225,000 chinook salmon alone should be produced by natural spawning in the Pacific Northwest. If properly managed, this should lead to a harvestable surplus of twice that number of chinook salmon annually in perpetuity. Because this economic pulse is sustainable, the value of all Pacific salmon species when one considers direct value of fisheries and tourism related to fishing is immense. Our large river systems suffered tremendous impacts in the past from hydraulic mining yet they were producing tremendous bounties of fish after recovery was allowed.

There is also economic benefits to making a transition to sustainable land and water management. Soil resources are the basis of all silvicultural productivity. By acting to prevent tremendous soil losses, we will maintain the future productivity of our forests. If we move to help farmers and ranchers invest in increased efficiency of water use, they can meet their water needs while allowing more water for fish and other public benefits. With the specter of continuing drought cycles, it is prudent that we make this investment regardless. Healthy riparian zones can reduce the risk loss of valuable agricultural land during future floods as well as playing an integral part in fisheries restoration.

We are now faced with the very real prospect of widespread extinction of Pacific salmon stocks. As a nation, we are all concerned about our current budget deficit and what portion of that debt we will leave to our children. If we fail to act decisively to save Pacific salmon, what will be the economic and cultural deficit that we leave to future generations? Continuing our haphazard approach will most certainly lead to the demise of these fish. The public recognizes the value of Pacific salmon and healthy river systems and will support sound solutions. The time for leadership has arrived.

Sincerely,



Patrick Higgins, Chairman
Environmental Concerns Committee

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Testimony of Bob Doppelt
Executive Director, Pacific Rivers Council
before the House Merchant Marine Committee
March 9, 1993

The degradation of The Pacific Northwest's riverine ecosystems and the extinction of salmon and other forms of riverine-riparian biodiversity have reached alarming levels. Not one river system in the region has been spared. Fisheries, healthy water quality and quantity produced by watershed ecosystems, and entire aquatic food chains are at risk.

For the past two years the Pacific Rivers Council has been involved with a major project to assess the capability of the region's (and nation's) riverine system and biodiversity conservation strategies and policies to address this crisis. The project has involved over 35 top scientists, economists and community development specialists nationwide. We conclude that the region's existing policies have failed. Entirely new strategies and policies must be established quickly to stave off the impending collapse of many riverine systems and to prevent wholesale biological extinctions.

THE EXTENT OF THE CRISIS: To realize the breadth of the problems one must first have a template of healthy ecosystems and biodiversity. Healthy river ecosystems in the Northwest are characterized by a number of factors including: 1) Water quality: All salmonids require high water quality for spawning, rearing and migration. Cool, well oxygenated water (generally <68 degrees F) free of excessive amounts of sedimentation and other pollutants is required year round, 2) Water quantity: adequate flows are critical at specific times in life cycles for spawning, rearing and migration. A natural flow regime that includes high flows is necessary to maintain channel complexity and to transport sediments, 3) Channel Characteristics: The most productive stream systems for most salmonids have gradients of <5 percent. These are lowland habitats composed of constrained canyons and gorges and unconstrained broad valleys which are generally sites of high fish densities. Good habitats maintain a balance between high quality pools, riffles, glides and side channels. Cover features such as large woody debris, boulders, undercut banks, overhanging vegetation, deep water and surface turbulence are abundant in good habitats. Substrates consist of a variety of particle sizes ranging from silts to boulders with low percentages of fine sediments to accommodate the spawning and rearing needs of all species. Channels are free of obstructions that interfere with migration of adult or juvenile fish; 4) Riparian Vegetation: Riparian areas regulate the exchanges of nutrients and materials from upland forests to the stream and maintain favorable microclimates. Large conifers or a mixture of old growth and hardwoods are found in riparian areas along all streams in the watershed, including non-fish bearing streams. Root systems in stream banks stabilize banks and protect them during high flows, 5) The condition of the stream is a function of the characteristics of the entire watershed. Healthy watersheds have upland portions that are well-vegetated and free of chronic and catastrophic sedimentation and other forms of disturbances that affect flow regimes, water quality and the delivery of large wood to the stream.

By the same token, healthy biodiversity requires a wide diversity and abundance of species and organisms, not just the presence of few key species.

However, whether measured by the health of riverine species, or by physical parameters, the current status of the Pacific Northwest's riverine ecosystems and fisheries is one of widespread degradation.

Loss of Fish Species: At least 106 populations of West Coast salmonids (salmon, trout, steelhead and char) have been driven to extinction and over 210 salmon populations are currently at risk of extinction according to the American Fisheries Society. The Sacramento River winter chinook salmon, and the sockeye and fall, spring, and summer chinook salmon of the Snake River basin are among the Pacific Northwest fishes listed as protected species under the Endangered Species Act. Petitions have been filed for sturgeon, bull trout, Columbia River coho salmon, Illinois River winter steelhead, and other fishes, whose listing could have widespread consequences for the region. Hundreds of other freshwater and anadromous fishes probably qualify for, and could receive, federal protection in the near future.

However, more than just salmon are at risk. The endangered salmon are just symbolic of a range of riverine and riparian biodiversity losses occurring across the Pacific Northwest. For example, at least 132 species of riparian associated animals, including 3 birds, 4 mammals, 12 amphibians, 45 mollusks, 34 anthropods and over 700 out of 1100 native fishes (estuarine, resident etc) on 348 streams were found to be at risk of extinction within the range of the Northern

Spotted Owl from the Cascade Mts. to the ocean (Northern Spotted Owl recovery Plan, Appendix D). Similar patterns and levels of depletion can be found in arid and semi-arid biomes throughout the region.

The economic and social impacts of degraded riverine systems and lost fisheries and biodiversity are severe. Just a few examples are necessary to depict the impacts. Since 1910, annual salmon and steelhead runs of the Columbia river system have declined from approximately 10-16 million to 2-2.5 million. Yet, the fishery still produces over $1 billion a year in income and supports 60,000 jobs regionwide (using 1988 figures). How many jobs and economic benefits could a healthy fishery produce? Further, diminished and polluted water supplies produced by the regions watersheds are affecting irrigation and municipal water supplies and threaten public health.

In short, almost every segment of society has been affected by and pays heavy direct and indirect ecological, financial, and job-related costs for the degradation of the regions riverine systems, fisheries and riverine biodiversity, whether they are aware of it or not.

THE CAUSES OF THE PROBLEMS: Although the media has generally focused the problems on mainstem Columbia dams, these types of broad ranging problems cannot be blamed exclusively on dams, nor on excessive fishing, or on predators such as sea lions. Over 175 of the 214 at risk salmonids spawn outside of the Columbia basin, most in coastal rivers unaffected by dams. Most of these species are not subject to commercial harvest. Poor ocean conditions, dams and overharvest would not explain the vast number of riparian species or resident fish such as Bull Trout that are at risk.

The cumulative degradation of watershed ecosystems and the loss of riverine habitat is the single most consistent contributor to the decline of the region's fisheries and riverine biodiversity.

The cumulative result of the many human impacts on riverine systems has been called "ecosystem simplification": huge reductions in the life-supporting complexity and diversity of watershed and riverine ecosystems and habitats.

In brief, riverine ecosystem and habitat simplification relates to: 1) changes in water quantity or flow due to irrigation and other withdrawals, 2) the modification of channel and riparian ecosystem morphology caused by damming, reservoirs, channelization, drainage and filling of wetlands, and dredging for navigation, 3) excessive nonpoint-source pollution, including erosion and sedimentation caused by damaging land-use practices, including agriculture, forestry, and urbanization, 4) the deterioration of substrate quality or stability, 5) the degradation of chemical water quality through the addition of point-source contaminants, 6) the decline of native fish and other species from overharvest and intentional or accidental poisoning, and, 7) the introduction of exotic species.

Loss of Physical habitat: Many scientists have linked the future of the region's native fishes directly to the changes in the management of federal forests and other lands across the region. Loss of physical complexity in lowland rivers which primarily flow through private lands is extensive. Virtually all lowland rivers throughout the region have been universally degraded through channelization, diking, leveeing, revetting and riprapping and excessive water withdrawals, thereby disconnecting the rivers from their floodplains and groundwater systems. An estimated 70-90% of natural riparian (streamside) vegetation, vital to maintaining the integrity of riverine ecosystems and biodiversity, has already been lost due to human activities. Seventy percent of the region's rivers have been impaired by flow alteration.

Loss of private land lowland habitats has placed much of the burden of maintaining the health of both riverine ecosystems and biodiversity on the federal forest lands in the region. While federal forest habitats have also been degraded, the best remaining habitats are found in the federal forests primarily in unroaded, steep watersheds dominated by old growth forests.

Even on the federal forests river reaches are degraded. Recent research has documented that fish habitat on National Forests and other lands currently has fewer pools, higher fine sediments in spawning gravels and fragmented riparian vegetation than is healthy. For example, the number of large deep pools in many tributaries of the Columbia river have decreased in the past 50 years in resurveys completed between 1989 and 1992 by Forest Service researchers. Overall there has been a 30 to 70 percent reduction in the number of large, deep pools (>6ft. deep and > 50 yd surface area) on National Forests within anadromous fish in the past 50 years. A similar trend has been found in streams on private lands in coastal and eastern Oregon, Washington, and Idaho where large deep pools have decreased by 60-80 percent. Large pools are important for anadromous fish as holding areas for adults for spawning, refuge from drought and winter icing, maintenance of fish community biodiversity and juvenile fish rearing areas.

The primary reasons for these losses are increased sediments, loss of stream sinuosity by channelization and loss of woody debris and other pool forming structures. Only in a few watersheds are exceptions to this trend: the Methow and Wenatchee rivers in Washington both of which contain large roadless areas.

THE NEEDS THAT MUST BE ADDRESSED

THE ECOLOGICAL NEEDS: Numerous scientific panels have confirmed that only a few pockets of healthy habitats and ecosystems remain regionwide (Scientific Panel on late Successional Forests, 1992 and American Fisheries Society, 1993 in press). These "key watersheds" act as physical refuges for fisheries and biodiversity and as a source of species to recolonize degraded areas once restored. These areas also are the key to maintaining the existing levels of health for the systems, and hence are the "anchors" for watershed restoration programs. It is imperative that these best remaining key watersheds be quickly identified and protected at the watershed level to provide a basis to maintain and restore the region's riverine systems and biodiversity. In addition, ecologically based riparian and floodplain protections must be immediately implemented across the landscape on federal lands.

Once protected, the key watersheds must be "secured" which means threats to the remaining healthy areas must be defused or eliminated.

Watershed level restoration plans should then be crafted and implemented. Each plan should be based on a watershed level analysis of the specific needs and varying conditions of the watershed. Long term monitoring is vital to insure that the restoration treatments are successful and to provide feedback for strategic changes in restoration goals and strategies over time. It is important to note that there are no quick fixes available. Restoration is a long term process. What needs doing immediately is to stop the hemorrhaging of the systems by identifying, protecting and securing the remaining healthy watersheds and riparian areas. Restoration efforts will provide more effective if built around the healthier areas.

THE POLICY NEEDS: The National Problem: In part, the problem is symbolic of problems nationwide. For example, the United States has no national goal to protect or restore riverine ecosystems or riverine-riparian biodiversity and no national policies that mandate coordinated federal, state, and private management and conservation of whole riverine systems. Traditional river assessments have been biologically ineffective. No policies require the identification and protection of the remaining healthy riverine habitats. No effective riverine restoration policies exist at any level of government. Finally, no policies effectively integrate riverine protection and restoration with local job creation and community revitalization.

Internal reviews by the Forest Service concede that maintenance of physical riverine habitat on national forest lands cannot be assured under current management direction.

Federal Land Management Policies and Guidelines are Inadequate: Despite the need to quickly identify, protect and secure the best remaining habitats, and to implement watershed level restoration strategies, current federal land management policies, standards and guidelines fail to address these needs.

A complete exposition on the failures of federal land management laws to protect riverine ecosystems and fish habitat at the watershed level is beyond the scope of this testimony. Suffice it to say that the problem is not that federal land managers lack some of the authority to protect these resources. The majority of the problem is that existing authority leaves too much to agency discretion. Some policy gaps do exist however, including legislative mandates to align agency missions, goals and management policies within watersheds. We know that the agencies have not used the power they clearly have to provide an adequate level of protection and to compel restoration. We conclude that they will not take decisive action without stronger, clearer statutory guidance requiring specific actions to address the current crisis facing river ecosystems and fish habitat on federal lands. A few examples of existing authority which has not been fully exercised follow:

(1) The National Forest Management Act (NFMA) prohibits timber harvest where "watershed conditions" will be "irreversibly damaged" or where "water conditions or fish habitat" will be "seriously" or "adversely affected." The Act also requires the identification of marginal lands deemed "unsuitable for timber production," such as where "resource protection or reforestation cannot be insured." In practice, neither of these provisions has prevented timber harvests which significantly degrade water quality and fish habitat.

(2) NFMA also requires that the agency develop planning guidelines which "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives . . . " a provision which has been interpreted in regulations to require: "[f]ish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." 36 CFR U 219.19. The agency has acknowledged its general duty to maintain a level of biodiversity "at least as great as that which would be expected in a natural forest" where "appropriate" and "practicable", but has not developed a policy which requires the use of those indicator species most sensitive to land management activities on a regional basis. 36 CFR U 219.27(g). Nor has the agency failed to adequately distinguish between species and populations (stocks) in determining its viable populations requirements. Litigation is currently underway which could result in judicial clarification of the scope of the Forest Service's duties.

The agency has also generally utilizes individual habitat criteria such as water temperatures to evaluate the health of streams. These criteria are woefully inadequate. As previously stated, the health of a stream is determined by the combination of a multitude of factors.

(3) The BLM's primary management statute, the Federal Lands Policy and Management Act, directs the BLM to "take any action necessary to prevent unnecessary or undue degradation of the [public] lands," but there is no statutory definition of unnecessary and undue degradation, and it is left entirely up to the agency to determine what actions are "necessary." Rather, the BLM may, but is not required, to protect biologically significant "areas of critical environmental concern" in developing and revising land use plans. To date, this mechanism has not been widely used to protect critical riverine habitat.

(4) Both agencies are subject to "multiple-use, sustained-yield principles," which require that listed resources, including watershed and fish habitat, to be managed for long-term productivity. These principles give the agencies clear authority to reject economic optimally as the primarily decision making criterion. These principles do not, however, provide any hard constraints on land managers, and require that agencies merely give "due consideration" to the various competing uses.

(5) The Clean Water Act requires the maintenance and preservation of the biological integrity of the nation's waters, but, to date, the Act has failed to prevent the massive landslides and stream sedimentation associated with logging in unstable watersheds -- despite the use of "Best Management Practices."

A Word On Enforceability: We do not overlook the fact that each of the agencies has developed guidance of various kinds which applies to the management of rivers and riparian areas. However, except for those few forests or districts with specific riparian management language in their land management plans, most riparian management guidelines which do exist appear as text in agency manuals and handbooks, provisions or technical guides, none of which is binding on the agency or legally enforceable by affected parties.

For example, the Willamette National Forest has promulgated a technical guide entitled "Riparian Management Guide." This is generally acknowledged to contain the most contemporary, scientifically defensible riparian protection standards in the Forest Service. However, this document does not itself contain any directives which are binding on the agency. Rather, it is an informally promulgated document, not subject to the notice and comment procedures of the Administrative Procedures Act, and not, therefore, enforceable against the agency in a court of law. See e.g. Lumber Prod. & Indust. Workers Log Scalers Local 2058 v. United States, 580 F. Supp. 279 (1984) (forest service manual provisions not binding because not promulgated by Secretary of Agriculture under a specific statutory provision and APA procedures); United States v. Fifty-three Eclectus Parrots, 685 F. 2d 1131 (1982) (agency pronouncement must be legislative in nature to have the force and effect of law, and be promulgated under a "specific statutory grant of authority" in conformance with Congressionally imposed procedural requirements).

Consistency: Not only do the BLM and the Forest Service have different riparian policies, the agencies are not internally consistent. For example, internal reviews in Forest Service Region 6 reported disparate standards and guidelines among forest plans for fishery resource protection, concluding that none of the plans reviewed ensure the continued viability of salmonid populations. (Heller et. al., 1991). As one investigator discovered, "planning criteria, indicators for measuring resource values, modeling assumptions, and analytic procedures varied substantially among forests, such that direct quantitative comparisons between plans are of only limited value." (Frissell, 1992). Likewise, standards and guidelines for riparian management varied considerably among forests: the Willamette (Oregon) and

Shasta-Trinity (California) National Forests have adopted a no-cut buffer averaging 100 to 200 feet wide, and ranging up to 400 feet, on all class I, II and III streams, while the Mt. Baker-Snoqualmie and Olympic National Forests (Washington) allow extensive logging in all riparian areas, with a few restrictions to prevent total stand removal. Few plans provide any protection at all for Class IV tributaries and fewer still protect riparian areas along headwater streams, despite their important contributions to the downstream environment.

An example of new authorities needed: 1) Inter-Agency Policy Consistency and Alignment to Manage at the Watershed level.

Although a number of federal statues speak to inter-agency coordination, agencies are still authorized to act based on their own statutory goals and mandates and internal agency priorities. Legislation which defines common missions and goals, and aligns agency management policies of riverine-riparian ecosystems and biodiversity is needed to provide watershed level coordination and consistency.

CONCLUSION: PRC believes that new policies is needed to provide uniform watershed protection and restoration directives for all federal land management agencies. These policies must include riparian management directives directly from Congress, elevating important issues of riparian policy from the lowest levels of administrative authority to the highest level of government.

THE NORTHWEST POWER ACT AND THE COLUMBIA BASIN

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 ("Northwest Power Act") rejected project-by-project evaluation of environmental impacts in favor of a program which must, to the greatest extent possible, address the entire 258,000 square miles of the thirty-one watersheds in the Columbia River basin. 16 U.S.C. ÙÙ 839-839(h). In order to achieve this goal, the Act created an independent regional planning body, the Northwest Power Planning Council ("the Council"). In addition to energy conservation and efficiency goals, the Council was required to "protect, mitigate and enhance" the fish and wildlife damaged by the hydrosystem, with specific emphasis on the improvement of flows and on providing bypass systems at major dams.

The Act's history indicates that Congress intended the Council to consider fish and wildlife resources "on a par" with other river uses as a "co-equal partner" with hydropower. The Council is also required to choose energy resources that minimize the total cost of providing energy services, with environmental costs included in the calculation of total cost. Positive biological results are given priority over economic considerations: minimum economic cost alternatives are favored only where biological goals are also attained, and the fish and wildlife agencies' and tribes' recommendations must be given "due weight" in making programmatic decisions.

The Council has proved ineffectual in forcing drastic changes to the hydrosystem and in changing federal land management practices. It was anticipated that the Council planning process would require federal dam operators, the states, the numerous river users and affected interests to act collectively to improve the condition of the Columbia -- primarily by providing the instream flows necessary to ensure passage of juvenile fish to the ocean. To date, however, the Council's Columbia Basin Fish and Wildlife Program, now in its fourth phase of development, has failed to resolve the "fish-power" conflict in a way that significantly benefits fish. It now appears that courts will ultimately be responsible for doing what the Council has not, in the context of pending lawsuits under the Northwest Power Act, the Endangered Species Act and other applicable law.

This is not to say the Council hasn't tried. For example, in 1988 the Council approved the creation of its "Protected Areas Program," which designated 44,000 miles of stream reaches on which future hydroelectric development is now severely restricted. These areas were designated based on the Council's determination that hydropower development would cause unacceptable harm to critical fish spawning grounds or wildlife habitat. Unfortunately, the legal effect of the Program to prohibit future hydroelectric development is limited by the Federal Power Act, which requires only that federal agencies such as FERC give the program "due consideration" "to the fullest extent practicable." The Program is also limited to the extent that it designates stream reaches outside the Columbia Basin, where FERC, the BOR and the Corps are not subject to the Northwest Power Act.

Numerous reasons have been posited for the Council's failure to force the necessary drastic changes in the operation of the Columbia River hydrosystem. Some believe that the Council's ineffectiveness could be cured by aggressive support from all four state Governors. Others believe that Congressional amendments to the Act are required because the Act's enforcement provisions are ambiguous, a circumstance which has prevented the Council from aggressively enforcing its Program, particularly with regard tc flows. To date, the Council's authority to enforce its own Program has not been tested, and federal dam operators tend to pick and choose which provisions of the fish and wildlife program they will implement. These and other problems with the existing regional planning process indicate that Congressional action may be required to save the anadromous fish resources of the Columbia river system. (Blumm & Simrin, The Unraveling of the Parity Promise: Hydropower, Salmon and the Endangered Species Act, 21 Envtl. L. 657 (1991)).

What should be done? Although the Northwest Power Act theoretically puts fish and wildlife on a par with hydroelectric and other values of the Columbia River system, even assuming that fish and wildlife habitat were actually accorded the parity it was intended to receive under the Act, there is no clear mandate to protect and restore river ecosystem functions as a priority over other uses. Although there are changes which can be made to operation of the hydrosystem which will vastly improve the odds for anadromous fish, flow alteration and improved fish passage facilities will not change the fact that the Columbia River system is so heavily developed with hydropower that it is unlikely ever to be restored to any semblance of its natural state.

Perhaps more importantly, changes in hydrosystem operation will not stop degradation of river ecosystems on the federal lands. It now appears that new legislation will be required which clearly recognizes that federal lands managers have a

responsibility to make drastic changes in their land use practices which directly affect over fifty percent of the Basin's remaining fish habitat. Drastic action is required to stop logging-related sedimentation and loss of large woody debris that has caused an average 60 percent loss of large pools on streams in national forests over the past fifty years. Likewise, decisive grazing reforms are critical -- particularly in areas such as the Snake River Basin, where analysts believe grazing practices are the single greatest source of habitat degradation.

THE FAILURE OF TRADITIONAL WATERSHED RESTORATION APPROACHES

A recent American Fisheries Society report found that "In the past 10 years, many millions of dollars have been spent on stream habitat management in Western North America. We find little documented evidence of increased abundance of salmonids associated with these massive expenditures."

Traditional approaches to stream habitat and ecosystem restoration can be characterized as "band-aid" approaches that have several distinguishing features. First, the identification and diagnosis of habitat problems tends to be focused on finding patches of habitat that are amenable to predetermined, generic techniques. For example, many past and current programs rely heavily on installation of log weirs to construct pools in streams. Planning for these projects generally focuses on identifying reaches of stream that do not meet water temperature standards or with gradient and bank structure suited physically to the installation of such devices, and that happen to be accessible to the heavy equipment needed to do the work. There is little consideration whether the fish community, or the watershed as a whole, are suited to the kinds of changes of habitat these structures are intended to induce. It is commonly assumed that all fish benefit equally from the plunge pool sequences created by such devices, and that the construction of weir pools will compensate for all of the diverse changes in the ecosystem caused by human disturbance.

Some evaluations of these projects indicate serious shortcomings. For example, where log weirs and other artificial structures achieve their physical objectives, their effects on native fish can be insignificant, or even negative. In other cases, they may stay in place, but have unintended and damaging physical side effects, such as severe bank erosion or blockages to juvenile fish migration. Finally, in many cases, such structures suffer a high incidence of outright physical failure. The results of numerous studies suggest that the effects of such projects are inconsistent and difficult to predict. Conditions in the watershed as a whole appear to be more important than structure design in determining whether structures will function or fail. Failure rates are especially high in severely damaged watersheds or stream reaches where disturbances are ongoing. Furthermore, in some watersheds fish populations are so widely depleted by extensive habitat degradation and other factors that few or no fish are available to colonize artificially created habitats. Finally, the vast majority of streams are not accessible to heavy equipment or are otherwise unsuited to structural modification. Put simply, traditional techniques fail to address the root biological and physical causes of habitat deterioration and population decline, and often aggravate, complicate, or add to existing problems.

Priorities for traditional "band-aid" restoration approaches are typically determined by identifying the worst-degraded or ugliest-looking sites, and spending all available resources treating these areas with generic and largely cosmetic structural techniques to "bring them up to standards." Once the desired improvements have been made, further habitat-disturbing activities in the watershed can be allowed to proceed.

The result of the "band-aid" strategy is predictable: disturbances are maximally dispersed across the landscape, and virtually all sites across the landscape are homogeneously degraded. The worst sites may be partially "fixed," but meanwhile disturbance-sensitive species have likely been lost through the entire stream system. As road networks and logging units are dispersed across the landscape, virtually every tributary and stream reach becomes vulnerable to management- accelerated disturbance from sedimentation and other effects when the next large storm strikes. Because no effort is made to identify and protect key watershed refugia, the most productive and diverse habitats are subject to continued disturbance, while the most severely degraded areas (inherently the least amenable to structural improvement, and therefore the most likely sites of project failure) receive all the restoration resources. In other words, this strategy is a recipe for the degradation of the remaining healthier watersheds and other kinds of secure ecological refugia-- leading predictably to the cumulative extirpation of formerly abundant, but sensitive species over large areas.

Past and present approaches to the management of watersheds and riverine-riparian have not only allowed the present crisis to develop, they have indeed exacerbated it. For example, the intense fisheries generated during periods when hatchery stocks are productive have often driven wild stocks into decline and local extinction. Perhaps worse, reliance on increasingly costly, heavily subsidized artificial production of hatchery salmon has facilitated the decline of natural

populations, by temporarily masking their loss. As even the most successful hatchery populations suffer the inevitable collapse from disease, genetic depletion, or technological failure, natural populations remain the only sufficient seed source to restore artificial production.

After a century of experimentation, there is little scientific support for the notion that salmon hatcheries are sustainable over the long term in the absence of wild, natural populations, or that hatchery technology can work to supplement or restore remnant wild populations without seriously harming them. Each wild population of salmon and trout is uniquely and subtly adapted to its environment, in ways that are not fully understood by scientists. These adaptations can be quickly lost in the hatchery environment or in the presence of large numbers of stray fish of hatchery origin. Therefore the viability of the species remains dependent on the conservation of the diversity of its wild populations and their habitats. Beyond this, wild populations adapted to marginal or disturbed habitats could in the future be the only source of suitable colonists for re-establishment of populations in an environment where, despite efforts toward restoration, human impacts will remain pervasive.

RECOMMENDATIONS FOR A COMPREHENSIVE WATERSHED RESTORATION PROGRAM

To protect and restore the Northwest's riverine systems, fisheries and biodiversity, we recommend a new approach founded on principles of watershed dynamics, ecosystem function, and conservation biology -- a community and ecosystem-based strategy that maintains and restores riverine processes and biodiversity at the watershed level. The new approach integrates ecologically and economically sustainable restoration strategies in a scientifically defensible and conservative way, emphasizing principles of the physical and ecological functions of watersheds and key spatial and temporal aspects of aquatic ecology. Simple in concept and pragmatic in application, this new approach provides a means for prioritizing protection and restoration policies and interventions and for creating more-rapid and cost-effective biotic recovery. This program would involve three interconnected components:

1) The program begins with a comprehensive effort designed to identify and protect the remaining relatively healthy headwaters, key biotic refuges, benchmark watersheds, riparian areas, floodplains, and the network of biological hot spots found in patches throughout entire river systems on federal lands. This cost-efficient approach places the emphasis on preventing further degradation rather than on attempting to control problems after they occur.

2) Following the protection of these areas, watershed level restoration programs should be developed. Restoration treatments should focus initially on "securing" or "storm proofing" the relatively healthy areas on federal lands stated above. After these areas have been secured, restoration would focus on providing better management between the protected areas and eventually linking and expanding the healthy areas. Private lands would be brought into the program to develop river system wide restoration strategies.

3) Finally the program calls for the active participation of local communities and citizens in implementing the restoration program. Without support from local communities and citizens, any policy will fail. To help generate support, local jobs in restoration technologies including the "storm proofing" of the key watersheds, and community revitalization projects must be created. These projects are needed to restore riverine systems, and they offer the benefit of providing jobs and economic benefits. Floodplain open space preservation and such economic conversions as new crops that are less water- and energy-intensive, and the protection of undeveloped floodplains must also be encouraged. Incentives and technical assistance must be provided to encourage local involvement in taking these steps and in designing and implementing watershed level restoration action plans.

Necessary Federal Steps:

To implement the new restoration approach, a coordinated strategic watershed restoration initiative is required. We recommend that the federal government establish the following:

* A coordinated strategic watershed protection and restoration initiative in the Northwest. The program must be a top-level national priority.

* A single department with clear policymaking authority to coordinate and implement the watershed protection and restoration program. Federal land management agencies can align their own policies. We recommend that

the watershed level program that includes private lands be operated by the Environmental Protection Agency (provided EPA is given cabinet status and its performance is greatly improved.)

* Uniform, consistent riparian, floodplain and habitat protection and restoration standards for all federal land management agencies.

* Ecosystem and watershed-level planning by all federal agencies.

* A comprehensive ecosystem-based watershed protection program for all federal land-management agencies. This includes the creation of a regional (and nationwide) system of "Watershed (Riverine) Biodiversity Management Areas" and "Benchmark Watersheds".

* A comprehensive ecosystem-based watershed restoration program that focuses initially on securing, linking, and expanding the remaining relatively healthy ecosystems and habitats.

* Coordinated private land and watershed restoration programs that generate local jobs and community revitalization projects, and support appropriate economic conversions.

* A moratorium on new dam construction, a national "protected river" program, and a process to prioritize, remove, and alter the most damaging dams and water projects within river systems.

* Stable long-term funding and sufficient financial and tax incentives for watershed restoration.

* Amendments to the existing federal land management agency rules, standards and guidelines so that they support the protection and restoration strategies, goals, and policies outlined in this testimony.

IMPLEMENTATION POLICIES: To implement the proposed goals and strategies, we recommend two immediate policy steps: the ***Watershed and Salmon Habitat Restoration Act*** and ***The National Watershed Registry.***

The Federal Lands Strategy: We propose that the strategies and policies proposed in this testimony be immediately implemented on federal lands through a **Watershed and Salmon Habitat Restoration Act** in the Pacific Northwest. Over 200 anadromous salmonids (trout, steelhead, char, and salmon) are at risk of extinction, and watershed ecosystems are highly degraded regionwide. At the same time, the region is certain to soon protect critical habitat for the Northern Spotted Owl and other species. Implementing the new federal land riverine policies in conjunction with the impending protection for these species will provide a more structured and integrated land protection and management scheme.

This Act will also provide a short term infusion of much needed jobs in rural communities.
For example, a draft estimate of the costs of securing 137 key public-land watersheds in the Pacific Northwest indicates that between 7,000 and 11,000 family-wage jobs would be created over the period of implementation. Much of this would involve heavy bulldozer and excavator equipment work to remove, upgrade or otherwise alleviate sedimentation problems caused by forest roads.

Ultimately, we recommend that these changes be made on federal land *nationwide* through a new *Federal Lands Riverine Management Act*: a comprehensive, uniform policy that would be applied to all federal lands and that mandates watershed-level, ecosystem-based protection and restoration. One uniform federal policy is needed to cut across the many conflicting policy fragments that exist today concerning riverine systems and biodiversity on federal lands. Federal lands are critical to the health of the nation's rivers: much of the remaining natural ecological capital and much of the remaining biodiversity is found on federal lands, especially in the West. These systems must be protected quickly to prevent further degradation and to provide the fundamental building blocks for long-term restoration.

The Private Lands Strategy: We propose the concurrent establishment of a National Watershed Registry to support existing programs and initiate new voluntary, non-regulatory state and local efforts to recover riverine systems on private lands. The National Watershed Registry is needed to support the many ongoing state and local efforts that have sprouted across the region but that currently are limited in effectiveness. It should also stimulate the growth of many new local efforts regionwide. The NWR would establish non-profit local watershed council on priority riverine systems that would

develop and implement, from the bottom-up, Watershed Restoration Action Plans. The federal government would provide grants, funding and technical assistance to these programs. The NWR would focus stimulating appropriate economic benefits to local communities in three ways: local jobs and restoration technologies, appropriate community revitalization projects, and economic conversions such as agricultural changes to less water and energy intensive crops.

A complete description of these proposals is found in our recently released report to Congress: Entering the Watershed: An Action Plan To Restore America's River Ecosystems and Biodiversity.

THE IMPERATIVE OF CHANGE

Although we evaluated numerous federal and state riverine policies and programs in preparation for this testimony, we have not spent a great deal of time recommending improvements for each. We believe that improving existing policies, although important to do, will still not provide the strategies, policies and incentives needed to initiate an era of comprehensive riverine restoration nationwide. No existing policies appear to be based on contemporary scientific assumptions or knowledge, or effective implementation strategies and mechanisms. Until new policies are enacted, most efforts in improving, properly applying, or enforcing existing policies will remain primarily "rear guard" actions. That is, they may (but likely will not) maintain the existing levels of health for some riverine systems for a short time. However, they are certain to fail to maintain riverine health in the long run or lead to comprehensive recovery. New federal restoration goals, strategies, and policies are needed.

We hope to see the region and nation turned toward new strategies and policies that will protect and restore riverine systems, fisheries and biodiversity. New approaches are certainly needed. Riverine systems are the life-support system of our nation. These systems offer important sources of food, timber, fiber, water, and many other products that provide both jobs and sustenance. From the remaining healthy riverine systems will come vital genetic resources to recolonize the environment for future generations. And it is the natural beauty and recreational opportunities of our region's and nation's rivers that uplift the human spirit.

It is in our self-interest to protect and restore the Northwest's and America's riverine systems and biodiversity. It is also our moral responsibility.

WRITTEN TESTIMONY
FOR HEARINGS ON:
"THE RECOVERY OF WATERSHED ECOSYSTEMS AND NATURALLY-SPAWNING SALMON POPULATIONS IN THE PACIFC NORTHWEST."

MARCH 9, 1993
CONVENED BY
THE SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES,
U.S. HOUSE OF REPRESENTATIVES

SUBMITTED BY:
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SCHOOL OF FISHERIES, WH-10
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Preamble:

Before commenting on the role of hatcheries in the restoration of naturally spawning salmon populations, I would like to emphasize that hatcheries can only be a part of the answer to this problem. Since salmon utilize an entire waterway from the origin of a stream to the marine waters, they are impacted by events that occur within these all of environments. Salmon reproduce and grow in the freshwater environment during their early life stages; they travel through this environment to get to and return from the ocean and, consequently, it must be of high quality and passable. The quality of the marine waters in which they spend the majority of their life growing must also be maintained. Finally, the salmon harvest must be reasonably managed if the naturally-reproducing populations are to survive. Thus, if we are to do an effective job at restoring the populations of this diverse and economically important natural resource, all factors must be considered when actions are taken that may have an adverse impact.

Question No. 1

Definition of a "best possible role" for hatcheries in the restoration of naturally-reproducing salmon populations is fraught with problems and contains a trap that has been opened and fallen into before. Simply stated, there is no single "best possible role" for hatcheries to accomplish this function. On a historical basis, this type of thinking has been a major factor in getting us into some of the problems we now face with naturally-reproducing salmon populations. To illustrate my viewpoint, I would like to cite two historical views of "the" purpose of the hatchery system with regard to Pacific salmon management and mention the problems they engendered.

The original purpose for developing fish hatcheries, in general, was to aid the restoration of naturally reproducing populations in streams and rivers where fish production had decreased or ceased to exist. However, during the latter part of the 19th century the prevailing view was that hatcheries were best used as a conduit for a stocking program to spread many species of fish across the continent. Since the culture of Pacific salmon was getting started about this time, large numbers of eggs from these species (e.g., about 51 million chinook salmon eggs from the McCloud River in northern California) were used for stocking programs across the U.S., including such unlikely places as Kansas and Missouri. It should be pointed out that this opinion was not unanimously held. Spencer Baird, the first head of the U.S. Commission of Fish and Fisheries, felt that fish culture was a tool that should be used to restore viable runs of anadromous fish. In spite of this opinion, a lot of effort was expended by the U.S. Commission introducing Pacific salmon species across the continent. While a few of the

programs led to the development of new and productive fisheries, most were failures. Perhaps more important than the waste of salmon resources was the ecological and genetic damage caused by introduction of exotic species into native populations of fish.

Later in the development of hatchery technology (1930's to the 1950's) intensive research led to the major improvements in fish nutrition and diets, fish disease diagnosis and treatment, and rearing techniques. The result was more effective and efficient hatchery operations that produced, apparently, healthier salmon. At the same time, there were increasing demands for the use of water in the Pacific Northwest for a variety of other purposes, e.g., irrigation and hydroelectric development. The prevailing view on the best possible use of hatcheries was as a replacement for populations of Pacific salmon displaced or destroyed because the water was needed for other purposes. The idea that hatcheries could simply replace the Pacific salmon to make up for production lost through destruction of freshwater habitat may have been in the back of the minds of the people who designed and built Grand Coulee Dam without fish passage. This single structure blocked salmon from more than 1,100 river miles of spawning and rearing habitat and, consequently, destroyed many naturally-reproducing populations of Pacific salmon.

The point of the above is not to place blame for the demise and the alteration of natural populations. In addition to limited views of the function of hatcheries, there was a lack of scientific knowledge about Pacific salmon biology and population structure; for example, it was not until the 1940's that it was accepted that these species "home" to a particular location to spawn. Irrespective of the explanations for past mistakes, single-minded and narrow definitions of the role of hatcheries in the dealing with Pacific salmon populations can be counter-productive and damaging. Further, such a view does not allow full use of the capabilities of hatcheries to assist in restoration of naturally-reproducing populations.

A more productive approach would be to define individual roles for each hatchery facility based on the needs of specific populations and the capabilities of hatcheries to meet these needs. As examples, I would like to use three different approaches to restoration. First, and perhaps most serious, are populations that are judged either "threatened or endangered". To attain this "status" a population must be in fairly dire condition and in danger of not being able to reproduce itself in the natural environment. Incidentally, a published report indicates there are about 214 populations of Pacific salmon close to this status in the Pacific Northwest. In this situation, the use of hatcheries as a temporary repository is the only option open to keep the population viable. Among the functions that need to be performed are the reproduction of the remnants of the population in a manner to retain remaining genetic variability, expansion of the population to "reasonable" numbers, and the production of adult fish to ensure the future reproduction of the population. This should be viewed as an emergency step that would be

temporary until the environmental constraints on the population(s) are removed and it can be safely placed back into its natural environment. A lot of current hatcheries should be able to meet this role, but special needs of handling and maturing adult fish must be considered.

The second situation where hatcheries can be particularly effective is where a population exhibits "under-escapement" (less than the optimum number of adults return to freshwater to spawn) due to diminished production of young fish. This is often due to water quality deterioration (e.g., siltation) that negatively impacts the incubation of eggs in the gravel or the viability of young fish after hatching. The population may not be at the level of being threatened or endangered, but should be augmented before that stage is reached. Hatcheries can be most effective and have the greatest variety of approaches that can be employed. The job a hatchery can perform best is to increase the survival of eggs and young fish above that in the natural environment. This can be accomplished by a very high technology hatchery, or by a very simple streamside incubation box. Thus, in this case the needs of the population can be addressed with hatchery technology that best suits the situation until the constraints on natural production are removed.

The final scenario is where there is under-escapement due to over-fishing. The most obvious and, perhaps, the best way to address such a problem is to decrease the fishing pressure by limiting catch, season, number of fishermen, or any number of other approaches. However, this can present many economic and sociological problems. An alternative might be to utilize hatcheries to produce salmon that do not interfere/interact with the naturally-reproducing population of interest and will relieve some of the fishing pressure from the population(s) of interest. Although notable success has been achieved with this type of "enhancement" of localized salmon fisheries in Alaska and Washington by use of specialized hatchery technology, this approach is the one most fraught with potential problems in regard to interaction with natural populations. Consequently, very careful control and monitoring are required.

All of these situations are commonly encountered problems with naturally-reproducing Pacific salmon populations and each can be addressed by use of hatchery technology. The common denominator among all of these is the need for an understanding of what has led to the problem noted. This makes it possible to identify and formulate a solution that will maximally benefit the population. Hatcheries should work, in many ways, like a research and development enterprise. That is, the problems should be identified, potential solutions formulated and conducted, and the work accomplished in a manner to enable evaluation of the results. The most apparent deficit in current hatchery operations is a lack of follow-up to assess and evaluate the results of the operation.

Question No. 2

Currently, the hatcheries have better basic husbandry techniques and rearing technology than have ever been available before. Fish diets yield better growth, more efficient utilization of nutritional components, and less pollution than at any previous point in the history of fish culture. Disease diagnosis and treatment is effective and new developments are accelerating with the incorporation of molecular biological approaches. The major problem in this area is the slow development and approval of disease treatment materials. Finally, although our water resources are being more extensively utilized than ever before, there are a variety of treatment technologies that assure adequate quantities of clean, well-oxygenated water.

All of this technological know-how can provide assistance for the restoration of naturally-reproducing populations of Pacific salmon. On the other hand, the major reason for its development is the more efficient and effective mass production of salmon. A close analogy can be drawn between these developments and those for the feedlot production of cattle, or for the modern production of poultry. While not inherently negative, some of the motivations behind these procedures are not necessarily compatible with the goals of restoration of naturally-reproducing populations. Emphases in the mass production of any animals include uniformity (both genetically and phenotypically), maximum efficiency, and standardization of the product. In comparison, effectiveness in restoration of natural populations should emphasize genetic and phenotypic variability, perhaps some inefficiency, and variety in the end product. The conflict between the need to efficiently mass produce large numbers of Pacific salmon and the biological requirements for the fish to be a viable part of the natural environment has been one of the major problems and conflicts in the use of hatcheries.

There has been some recent experimentation with alternative approaches to raising fish in a hatchery environment that suggest some of the problems can be alleviated. A major criticism of fish released from the hatchery is that they have developed an array of behavioral traits that do not allow them to survive well in the natural environment. Such behaviors as predator avoidance, antagonistic responses to other fish, feeding habits, etc., are lost or altered with standard hatchery practices. Alteration of feed dispersal methods and time of feeding, decreases in fish density, rearing in a more natural surroundings, and "training" in the presence of predators have all demonstrated the potential to yield fish more prepared to cope with the natural environment. In addition, the development of techniques to satisfactorily raise adult salmon to maturity in marine net-pens has increased the potential to reproduce populations for restoration purposes. While it will never be possible to raise an exact replica of a natural fish under artificial conditions, initial results from research have revealed that some of the major problems can be altered with relatively minor modifications of husbandry procedures.

Raising Pacific salmon in a hatchery environment holds the potential to alter their natural life history traits and to decrease the genetic diversity of the population. This, too, can decrease the chances of "restoration" salmon "fitting" back into the natural environment and producing a viable population. One answer to these concerns is to be able to monitor changes and take corrective action. Life history traits are extremely difficult to monitor because of the nature of their expression. These traits result from a combination of the impacts of the environment which the salmon experience and their genetic composition. We have learned much about the genetic determination of a number of these traits (e.g., timing of maturation, timing of smoltification, precocious maturation, and spawning and return timing) and can estimate the relative importance of genetic factors and the environment. Avoidance of genetic changes can be accomplished by attention to reproductive and rearing practices. However, monitoring can only be achieved by keeping complete records and noting the occurrence of changes in a population. Such information is not routinely kept in most hatcheries.

The best approach to eliminating potential problems with life history changes is to reproduce and raise fish without introducing selective changes or diminishing variability. While this easier said than done, it is important to make the attempt. The importance of this factor can be illustrated by the fact that, historically, there were probably salmon migrating in and out of the Columbia River almost the entire calendar year. Currently, due to changes in the river and to the procedural operations of the hatcheries on the river, most salmon move out of the river during a 6-8 week time frame. This overloads both marine and freshwater systems and causes interactions that previously did not occur.

Objective measurement of genetic diversity can be a bit more easily accomplished. Although the tools for analysis of genic variability in salmon were developed relatively recently, there are now a variety of techniques available and more are being developed. Protein electrophoresis is currently used to genetically identify and characterize populations of Pacific salmon. This technique has provided information to define population structures in Pacific salmon species, to identify problems with hatchery breeding procedures, and to define the population composition of harvested salmon. The Washington Department of Fisheries now operates a laboratory dedicated to the electrophoretic analyses of Pacific salmon populations within the state to assist in the management of these species. Molecular techniques utilizing nuclear and mitochondrial DNA have been very limitedly employed to this point, but they promise to yield important additional information. Each of these provides a "snapshot" of the genetic variability within and between populations and each has been utilized to monitor genetic change. However, more consistent, long-term and extensive use of available genetic analyses need to be employed to provide a basis for determining the meaning of genetic change in Pacific salmon populations.

Question No. 3

The current hatchery system, in my view, is capable of able to meeting the challenge of the restoration of naturally-reproducing populations of Pacific salmon. I am not as certain about other species of fish, but my impression is that some extensive "retooling" and development of basic fish biology and culture information will be needed for some of the less extensively cultured species that are threatened or endangered.

With regard to the salmon, there are a couple of active programs directed toward restoration of naturally-reproducing salmon populations. The Redfish Lake sockeye program on the Snake River is progressing as well as can be anticipated based on the information base that is available on this population and this species. A program operated by the Washington Department of Fisheries in cooperation with the National Marine Fisheries Service to restore a viable population of chinook salmon on the White River in the State of Washington is progressing rather well and has resulted in the development of captive broodstock procedures for this species. These two programs were, basically, undertaken with current technology supplemented by some experimentation to develop workable procedures.

There are, however, some important changes that are needed in the current hatchery system to facilitate restoration and to eliminate negative impacts from normal operations. The most important, in my mind, is to get away from the "narrow" approach to the use of hatchery facilities. A lot could be accomplished by setting individual goals for the hatcheries based on the most "pressing" salmon population problems and utilizing the full capabilities of the facility. Not every hatchery needs to be operated with a "feed lot" mentality to produce the maximum number of fish possible. Some "supplementation" hatcheries are needed to reseed streams and augment others with the most "natural" salmon that can be produced. This may, initially, involve using some expensive and inherently inefficient approaches; success in these endeavors will, however, eventually result in no cost. Finally, some "conservation" hatcheries are needed that utilize non-traditional facilities and rearing approaches (e.g., lower density rearing, fewer large containers for rearing fish and more small ones, analytical labs, permanent marking facilities, etc.). Such facilities will provide the best chance for Pacific salmon hatcheries achieving success in what has been a non-traditional role.

TESTIMONY OF JEFFERY P. KOENINGS, Ph.D.

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ALASKA DEPARTMENT OF FISH AND GAME

BEFORE THE

HOUSE SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES

WASHINGTON, D.C.

March 9, 1993

Mr. Chairman and Members of the Subcommittee, thank you for this opportunity to come before you today to discuss Alaska's fisheries program; in particular, our experience in culturing salmonids. I am Dr. Jeff Koenings, Director of the Fisheries Rehabilitation, Enhancement and Development (FRED) Division, Alaska Department of Fish and Game.

First, before discussing Alaska's successful hatchery program, I would like to place it within the context of Alaska's highly successful fisheries management program.

ALASKA'S SALMON MANAGEMENT PROGRAM

1. *Early Efforts to Rationalize Fisheries Under State Management*

Alaska was one of the first fishing regions to implement meaningful fishing restraints in the form of limited entry in salmon and herring fleets. We may not understand all of the efficiency consequences of these actions yet, but there is some evidence that these policies have slowed the growth of fishing fleets and allowed the industry to capture some profits. While these restraints were implemented swiftly by the State of Alaska, in contrast, it has been a struggle for the federal management agencies to consider and implement these types of mechanisms, even in the few cases where interest groups were in favor of them[1].

2. *Recent Efforts to Assign Limited Property Rights in Alaska*

If the central problem of coastal fisheries is an inability to assign sufficient property rights to promote efficient use of the resources, some decentralization of management may generate improved efficiencies. In Alaska, regional aquaculture associations and

[1] Significant efforts to limit federally managed fisheries and implement measures such as ITQs did not occur until well after the creation of the Magnuson Act.

regional planning teams have been formed to harness the collective interests of local fishermen. In these groups, fishermen have been granted some rights to determine (1) how many fish they may produce and of what species, and (2) how much to assess themselves for aquaculture activities. In many cases, regional aquaculture associations are involved in the management of the stocks and frequently take actions to conserve stocks. It seems unlikely that a highly centralized approach to management would initiate a system like this. It appears to us that decentralization leads to determining production levels and inputs that react to economic conditions more quickly and more efficiently.

3. *Decoupling Biological Management and Resource Allocation*

The Alaska Department of Fish and Game is the designated management authority for sustained-yield biological management. The Alaska Board of Fisheries has been given the authority and responsibility to allocate the available harvestable surplus between users. This arrangement effectively separates the local management biologist from pressures from different user groups, be they different commercial gear types or sport/commercial/subsistence interests.

4. *Using Local Fishing Knowledge to Aid in Management*

In Alaska, local area fishery managers are given a great deal of management authority. In communities that are close to the fishing grounds and have large numbers of participants in the fishing fleets, managers frequently find that local knowledge is an important aid in making preseason and inseason decisions. Decentralized management promotes use of this local knowledge. Additionally, laws of Alaska establish a "test fish fund" which allow fish captured during research activities and stock assessment activities to be sold in the name of the state and used to fund these projects. Without local fishermen support, it would not be politically possible for the state to operate in this manner since each fish caught comes directly from the potential catch of affected fishermen.

5. *Benefits Associated with Public Involvement*

More centrally controlled fisheries might impose additional legal costs on management if the public is not adequately involved. In Alaska, the Board of Fisheries develops regulations that describe how fisheries will be conducted. The membership consists of a seven-member panel, with representation from interest groups and industry. Members from any and all interest groups may present regulatory proposals and testimony to the board. While the system is occasionally cumbersome, the open system is generally considered as participatory and "fair," and is believed to reduce the probability of litigation from private parties over other centrally controlled management options.

6. *Importance of Keeping Management Close to the Fishery*

Overly centralized management of fisheries might not only lead to all biological but all economic analysis occurring far from the fisheries. Economists frequently must

rely on focus sessions with fishermen and other testimony to build economic models. Resulting computations of the net benefits to society, which are generated far from the fishing grounds, have often been found to be out of touch with reality—excluding benefits derived from experiences of fishermen and processors.

THE ROLE OF HATCHERY FACILITIES IN THE RECOVERY OF NATURALLY SPAWNING SALMON POPULATIONS

As Alaska's fish management and habitat protection programs have proven very successful, the hatchery program, which I will detail below, has concentrated on the enhancement of salmon stocks rather than on wild stock restoration programs. Early on, it was stressed that hatchery production would supplement, not supplant, wild stock production; hence the development of the rigorous genetics and fish health policies to guide the program. We are now applying the hatchery technologies we developed to the restoration of salmon populations.

Question 1. ***Given the lessons learned from past hatchery practices, what is the best possible role for hatcheries in the restoration of naturally spawning salmon populations?***

In my opinion, salmon hatcheries have been misused. The construction of a hatchery has been the common mitigation for fisheries habitat alteration or destruction. These large facilities were monuments to the good intentions of society toward the fish. People who might have otherwise questioned the loss of the salmon were convinced that hatcheries would more than compensate for the loss of necessary habitat.

The success of hatcheries was most often judged simply by how many fish were released, not by the condition of those fish; or, perhaps most important, not by the survival of hatchery-produced fish to adult. Unfortunately, this practice was often the rule and, perhaps equally unfortunate, is the common stereotype of salmon hatcheries today that was generated from these activities. Some people now contend that the best possible role for hatcheries in the restoration of naturally spawning salmon would be to close the facilities. All hatcheries do not fit this stereotype. Some hatchery programs lived up to the expectations of those who designed the programs. We have also learned from failures in the past. I feel that the application of modern hatchery practices may be necessary for the timely restoration of naturally spawning salmon populations.

Hatchery production can be used in several ways to assist in the restoration of naturally spawning salmon stocks:

- To supplement the production of naturally spawning stocks of fish;
- As a management tool to divert fishing pressure from stocks of naturally spawning fish;
- As a subject of research designed to understand both the effects of environmental parameters and the activities of man on the survival of fish; and

- In extreme measures to prevent the immediate extinction of unique stocks of fish.

Supplementation is the hatchery production of fish from selected stocks which are then placed back with the progeny of naturally spawning fish. Successful supplementation requires the application of fish culture practices to minimize the domestication of fish as they pass through the hatchery and are returned to their natural habitat. The role of supplementation in stock restoration is to add needed numbers to declining stocks of fish. In some instances, this may ensure the existence of that stock until habitat is restored and resource management is adjusted so that the stock becomes self-sustaining. Supplementation is also used to enhance self-sustaining stocks to support increased harvest.

There are also situations when hatchery programs can be designed to add fish to traditional common-property fisheries. These programs provide a tool for resource management and ***divert fishing pressure from selected naturally spawning stocks of concern.*** In order for this strategy to be successful, the hatchery fish must not alter or significantly compete with the wild stocks. At harvest, the hatchery fish must be separated from the wild fish by either space or time. A secondary benefit of this strategy is maintenance of selected fisheries and associated economies while, at the same time, diminished populations of naturally spawning salmon are protected.

We have far greater control of hatchery-produced fish than of naturally spawned fish. ***Hatchery fish are used in controlled situations to help fisheries scientists understand and identify those things that affect the survival of naturally spawning salmon.*** Identifying factors detrimental to wild salmon as well as modeling the optimal situation for the survival of members of a given stock of fish is critical to the restoration of naturally spawning salmon stocks. In Alaska, we have determined such things as the specific relationship of yearling sockeye salmon smolt size, or the timing of smolt migration to the sea, with the chance the fish will survive to return as adults. This knowledge is used to evaluate the health of a wild population. It can also be used to predict the impact of habitat alteration, either correction or degradation, associated with the activities of man on wild salmon stocks.

Hatcheries can be used to sustain severely threatened salmon stocks until sufficient numbers of fish and appropriate habitat are available. The hatchery may be used to "bridge over" life history voids: too few adult spawners to sustain a stock in natural conditions, inaccessible or altered spawning grounds, impassible migration corridors, or inaccessible or altered freshwater rearing habitat. In the summer of 1990, only one female sockeye salmon successfully migrated up the Columbia and Snake Rivers to Redfish Lake in Stanley Basin, Idaho. There was virtually no chance this single female could have naturally spawned and produced a sufficient number of offspring to perpetuate the Redfish Lake sockeye. Extreme fish culture practices, including developing a hatchery-reared, captive brood stock, were used to perpetuate this stock that had been reduced to several thousand eggs in a single female.

In summary, it is my opinion that there is no single, best way that hatcheries can assist and speed the restoration of naturally spawning populations of fish. As many of

these stocks are unique, so are the habitats that support them. Though many salmon stocks have been diminished due to general common problems, in fact the situation of most of these individual populations today is unique. Specific hatchery practices, similar to those generalized above, can be designed and used to assist in the restoration of most unique stocks of naturally spawning salmon.

Question 2

A. What artificial production techniques and systems are available to assist in the restoration of naturally spawning salmon populations?

- eyed-egg plants from hatcheries
- fry plants from hatcheries
- smolt plants from hatcheries
- lake enrichment

B. What monitoring systems are available to preserve life history and genetic diversity?

- Many monitoring systems are available, but their implementation will not preserve life history and genetic diversity. One has to control, through policy development and regulations, the manner in which the business of salmon restoration is conducted if one hopes to maintain genetic diversity. Simply put, the behavior of humans with regard to the fish has to be controlled. In Alaska, we accomplish this with a permit system that controls the movement of fish used for aquacultural purposes and with rigorous policies on fish disease and fish genetics that are backed with modern laboratories and highly skilled scientists.

C. Where are such techniques in use and what has been the extent of their success?

I have used the term before, but in the Pacific Northwest, I believe the word "supplementation" is used to describe the process of artificially adding to the number of individuals in a naturally spawning salmon population. For clarification, let's make sure what exactly we are talking about. In Alaska, when we conceive of rehabilitating the fish in River X, we are speaking of performing an egg take on River X, taking the eggs back to a hatchery for incubation, and releasing the resultant juveniles back into River X. The objective is to bypass the heavy mortality that Mother Nature usually inflicts upon eggs laid in the gravel in the wild. We use, as a rule of thumb, that only ten percent of the eggs in River X will produce juveniles, but 90 percent of those taken to a hatchery will produce juveniles. The ultimate goal is to boost the number of fish in the system to a higher level and that this higher level will be self-sustaining. Clearly, and this is extremely important, self-sustainment will not be achieved if whatever factor causing the population to decrease in the first place is allowed to remain operative: declining habitat, overharvest, unusual predator concentration, and some shifts in the carrying capacity of the environment.

Some people in the Pacific Northwest have concluded that supplementation does not work. I would be very careful about concluding that. Certainly, there are cases to

point to that have not worked. In most instances, it is very popular and therefore easy, to make and release fish, but to correct the mechanism that made the natural populations decline in the first place can be exceedingly difficult.

I can give you several examples from Alaska that have fit the definition of supplementation and have worked:

- Upper Thumb River (Karluk Lake) sockeye salmon, Kodiak (completed)
- Farragut River chinook salmon, Southeast (ongoing)
- Chilkat River chinook salmon, Southeast (ongoing)

To date, we have had no experience at rehabilitating salmon stocks on big rivers analogous to the Columbia. But we are about to get our feet wet on the Yukon River:

- Toklat River chum salmon (ongoing)
- Chena River Arctic grayling (ongoing)

Also important is our successful experience in establishing self-sustaining runs in previously fishless habitats:

- Frazer River sockeye and chinook salmon (completed)

Other examples can be cited, but I must add that, despite our successes, Alaska does not consider hatcheries as a substitute for careful management. In fact, the Alaska Legislature mandated that fish stocks shall be managed consistent with sustained yield of wild fish stocks.

Question 3. *Is [Alaska's] hatchery system presently able to perform the tasks necessary for the survival and restoration of naturally spawning fish populations? If not, what changes are necessary?*

Hatcheries have various purposes: one being wild stock supplementation or restoration, the other being enhancement. Hatcheries (or various artificial propagation techniques) are a functional tool for restoring naturally spawning fish populations, but strict guidelines governing this use should be established prior to the implementation of any restoration project.

Ecosystem recovery must be based on a holistic approach. Overfishing, loss of spawning and rearing habitat, prolonged competition from introduced species or hatchery-produced fish of the same species, and barriers to migration are common problems leading to the decline or loss of naturally spawning fish populations. Fortunately, these occurrences are relatively rare in Alaska; unfortunately, they are common in the Pacific Northwest. The first step in the restoration process involves identification and correction of causes leading to the decline or loss of a naturally spawning fish population. As I have stated before, there is no point in initiating a restoration project if these causes persist.

If a naturally spawning fish population has been lost or cannot be brought back to a viable population strength through stricter management protection or habitat restoration, then supplementation will be required. A sound rule of thumb is to go in, get the job done, and get out. The use of hatcheries or artificial propagation techniques should be limited to one or two life cycles of the affected species. Prolonged supplementation using hatchery-produced fish will only result in the replacement of wild fish with hatchery fish, which really defeats the purpose of restoration. In cases where a naturally spawning fish population has been completely eliminated, a donor stock will have to be used. Local or genetically similar stocks should be used for replacement.

The keys to the performance of successful hatchery programs in Alaska include the following:

- The design and adherence to extensive fish culture protocols maximize the survival of the fish while at the same time mimicing the natural situation for those fish as much as is reasonable. There has often been extensive, creative interaction between fish culturists, fisheries scientists, and resource managers in the planning of all fisheries restoration and enhancement activities. That planning is brought to fruition through the application of these restoration and enhancement protocols, including the appropriate fish culture practices.

- The consistent evaluation and reevaluation of all critical procedures, coupled with the flexibility that allows rapid revision of those procedures is essential. We make very few assumptions. Everything that is done in the most successful hatcheries is consistently evaluated. The ultimate evaluation of fish culture procedures is the survival of hatchery-produced fish to adults. The evaluation of restoration activities would include accomplishing the intended, overall program goals.

- We realized that many restoration projects are unique, and we accepted both the risk and failures associated with the willingness to sometimes design unique, one-of-a-kind protocols for specific situations. The successful culture of sockeye salmon was a result of this willingness. Alaska now has the largest and most diverse sockeye salmon restoration and enhancement program in the world.

Finally, Alaska's hatchery program began in 1971 after harvests of wild stocks of salmon fell to around 20 million fish. Presently, the wild stock harvests have reached nearly 150 million salmon, with an additional 20 million catch contribution from the enhancement program. This is consistent with the original goal of the program to supplement wild stock production, not supplant it. Wild stocks remain the backbone of the salmon industry, and it is the intent of the Alaska Department of Fish and Game to keep it that way.

Thank you for this opportunity to come before you today to discuss Alaska's salmon fisheries management and development programs.

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Testimony of John A. Sayre, Executive Director of Long Live the Kings, given at a hearing in Washington D.C. on March 9, 1993 before the U.S. House of Representative's Subcommittee on Environment and Natural Resources. The subject is the potential role of hatchery facilities in the recovery of naturally spawning salmon populations. The following comments should address most of the specific questions the Subcommittee members asked.

RESTORATION PROJECTS FOR NORTHWEST SALMON

If the Northwest is to once again have a bounty of salmon, restoration of damaged runs and habitat must be a priority for all salmon advocates. The hard facts are:

- most of the rivers are dammed,
- most of the watersheds are logged,
- most of the water is appropriated

While it is essential to continue efforts that protect remaining pristine habitat and save wild salmon stocks that are in danger of disappearing, the future lies in restoration. We need to fix a system that is broken biologically and mismanaged politically.

Development of a restoration strategy requires a vision of what we want. Considerable damage has been done to Northwest salmon. But we forget that they are one of the world's greatest renewable resources, one that has displayed remarkable hardiness, survivability, and adaptability over the centuries. Only 15 years ago these fish supported a regional fishery that attracted anglers from around the world. Salmon were the lifeblood of thriving coastal communities.

Long Live the Kings (LLTK) believes that salmon can once again be restored to such levels. Our goal is a return to a flourishing year-round fishery that annually brings hundreds of thousands of visitors to the area and returns hundreds of millions of dollars to the Northwest economy. This can be done by protecting and rebuilding wild runs, and by applying innovative hatchery programs that can support viable commercial, tribal, and sports fisheries without hurting wild fish.

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Wild fish don't need human help to spawn. Left alone, they produce the hardiest offspring, and that reproductive process doesn't cost the taxpayers a dime. Ideally, the best ways to restore salmon are: 1) make sure that enough of them escape fishery pressure to fill the available spawning habitat and, 2) increase the amount of that habitat. Unfortunately, we're several million people too late. Too much habitat has been destroyed and too many wild salmon stocks need major help to reach even minimum escapement numbers, let alone to produce enough fish to maintain existing fisheries.

This is where LLTK comes in. When LLTK was established in 1986 it was then the only private group in the Northwest given permits to do "hands-on" work with wild salmon runs. As a result, we now have six years' experience in:

- wild salmon brood stocking--capturing wild adults to take their eggs,
- supplementation--rearing wild fish in captivity to increase their survival from egg to smolt and then releasing them back into their native river to increase the numbers of naturally spawning adults,
- habitat restoration-- opening up old gravel pits along rivers to provide new spawning areas for wild fish,
- techniques to maintain wild characteristics of
- fish in captivity--providing shade and hiding places, letting vegetation grow around ponds to provide natural feed and volitional release of fish so they migrate out on their schedule and not the hatchery manager's schedule.

This work has gained LLTK credibility with fishery agencies, tribes, fishermen, and helped lead to the passage of a state law establishing 12 regional groups in Washington state to enhance salmon runs. The program has a dedicated fund from surcharges on sport and commercial fishing licenses that raises $700,00 annually. Many of these groups base their programs on techniques developed by LLTK.

While the development of restoration efforts was important six years ago, today they've become critically important because of the potential impact of the Endangered Species Act.

Long Live the Kings operates three problem-specific restoration projects, all in cooperation with Native American tribes, state and federal fish agencies and local community salmon enhancement groups.

- At Lilliwaup, on the Hood Canal, we are experimenting with captive broodstocking--rearing depleted wild stocks to sexual maturity in captivity. This technique holds on to

threatened gene pools until factors limiting their survival are addressed.

. Our Wishkah/Wynoochee River project, near Grays Harbor, focuses on how to supplement wild fish populations in logged areas until they can re-establish themselves through natural spawning, and creating new spawning and rearing habitat.

. Our project on Orcas Island, in the San Juan Islands,

demonstrates how hatchery salmon stocks can be totally separated from wild stocks, thus allowing fisheries that don't conflict with wild fish.

Let me elaborate on these projects:

1. HOOD CANAL WILD COHO RESTORATION

LLTK's wild salmon facility at Lilliwaup, Washington, will be completed this month. It is a "state of the art" hatchery and rearing facility built with $600,00 of private funds from foundations, corporations and individuals.

The project is a cooperative effort between LLTK, the National Marine Fisheries Service, the Washington Department of Fisheries, the U.S. Fish and Wildlife Service, the Point No Point Treaty Council, the Skokomish Indian Nation and the Hood Canal Regional Salmon Enhancement Group.

This facility will be a "captive broodstock" site for Hood Canal's wild Coho salmon. These stocks were so depleted last year they caused an unprecedented two month's fishing closure. A small number of eggs and fry from wild salmon will be captured in Hood Canal Rivers and reared at Lilliwaup. They will be held in captivity in freshwater until sexual maturity. Some fish will also be reared in saltwater net pens for comparison of survival. The eggs and progeny from these fish will then be placed back into their native rivers, thus dramatically increasing the number of juvenile fish going out to the ocean.

A series of techniques will be used to learn how best to re-introduce the juvenile fish back into the rivers. This project offers the opportunity of restoring depleted wild fish faster than any other method and will be usable throughout the Northwest.

In addition, two spring fed streams that flow through the hatchery have had weirs and spawning gravel added to increase natural spawning areas for wild fish. This fall

some 60 wild salmon spawned in the middle of the hatchery site.

A similar program is underway with wild Chinook on the Dungeness River in Washington state.

2. WISHKAH RIVER/WYNOOCHEE RIVER WILD SALMON RESTORATION

This project experiments with supplementation--capturing wild adult salmon and taking their eggs into a hatchery to increase survival. The Wishkah River water shed is almost all logged off. This summer, the last remaining timber around the LLTK facility will be clear cut. Instead of pulling out, LLTK is working with the company doing the logging to build a new series of ponds for wild-fish restoration. These ponds will be for spawning and over-wintering wild fish. LLTK will make the Wishkah an example of how to bring back wild fish and their habitat in a logged area. The first Chinook that were tagged and released--in June 1988--returned this fall as four-year old fish (weighing in the mid-20-pound range) to spawn naturally in the Wishkah River. We know this because we captured several of the tagged fish in our brood stocking program, and observed many more spawning. This clearly indicates supplementation is working.

In addition, we had the highest returns yet of wild Wynoochee River Chinook offspring to our joint program with Washington Department of Wildlife at Lake Aberdeen. The Chehalis Basin Fisheries Task Force has also had great success with it's wild Coho and Chinook supplementation program in the Satsop River.

When the minimum escapement goals for naturally spawning fish is these rivers are met three years in a row, LLTK will cease using the hatcheries to supplement wild fish.

LLTK is also working with timber company gravel pits on the area rivers to demonstrate they can be restored as valuable natural spawning and rearing habitat for wild fish. We've also dug new ponds in small watersheds that fill up in winter flows and provide over-wintering habitat for thousands of juvenile wild fish.

3. ORCAS ISLAND GLENWOOD SPRINGS SALMON RESTORATION PROJECT

LLTK has recently taken over a privately owned hatchery on Orcas Island in Washington State's San Juan County. This facility has operated as one of the most productive, cost-effective fish-rearing facilities in the state. State budget cuts eliminated the funding for this project. LLTK will assure funding through a cooperative effort with the

commercial, tribal, and recreational interests that benefitted from these fish. It will be an to hatcheries on rivers that harm wild fish. This facility has a spring water source with no wild fish, a direct release site into salt water with no negative impact on wild fish, and a terminal area fishery with no mixed-stock fishing with potential impacts on wild fish. The sale of excess eggs and carcasses could cover the operating costs.

If this operation were duplicated in similar sites with adjacent water sources, it would greatly benefit fishermen and relieve pressure on wild fish. In addition, the site will also be used for captive broodstock rearing of North Puget Sound depleted wild stocks.

The Glenwood Springs Salmon Enhancement Project began in 1978 as a private non-profit effort to enhance depleted stocks of Coho and Chinook salmon in the northern Puget Sound area.

The initial stocks of Coho and Chinook came from the Samish River hatchery near Burlington and were transferred as "eyed" eggs for the initial three years, after which the program became self-sustaining.

The original Coho rearing and release program resulted in returns of up to 10 percent to Eastsound area and justified the state opening a terminal net fishery.

The Chinook program was even more successful. We had excess eggs after three years. In 1988, Glenwood Springs generated a surplus of over three million eggs in addition to filling its own rearing capacity needs of 400,000. This was all in addition to a commercial purse seine and gillnet fishery in Eastsound Bay that allowed a catch of approximately 5000 adult fish averaging 20 pounds.

LLTK believes hatcheries can play a major role in recovering wild salmon and in maintaining viable fisheries economies. Without hatcheries, wild fish alone could not maintain existing sport, commercial and tribal harvests. It is desirable to restore wild fish to the maximum extent possible and to maintain hatchery production to serve existing fish constituencies. The challenge is to restructure hatchery operations to minimize conflicts with wild stocks. If we truly start restoring watersheds to wild productivity, then the hatchery role should be diminished.

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Testimony
of
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before the
Subcommittee on Environment and Natural Resources
Committee on Merchant Marine and Fisheries
U.S. House of Representatives

on
Role of Hatcheries in the Recovery
of Naturally-spawning Salmon Populations
in the Pacific Northwest

March 9, 1993

The Honorable Gerry E. Studds, Chairman

Mr. Chairman and members of the Committee, my name is Anne Kapuscinski. I am an Associate Professor of Fisheries and of Conservation Biology in the Department of Fisheries and Wildlife, and an Aquaculture Extension Specialist with Minnesota Sea Grant and the Minnesota Extension Service at the University of Minnesota. In addition to direct experience in operation of salmon hatcheries, I have conducted research for 16 years on fish culture and fish genetics with an emphasis on salmon and trout, and have been involved in several Columbia River Basin efforts to improve genetic conservation in hatchery programs. In 1991, I conducted a genetic analysis of hatchery policies and guidelines used by fisheries management agencies in the Columbia River Basin (Kapuscinski 1991). Currently, I am on a Yakima/Klickitat Fisheries Project scientific team which is developing genetic hatchery guidelines, genetic risk assessment protocols, and genetic monitoring tools for hatcheries used to rebuild salmon populations. My comments below will apply to salmon and steelhead trout populations; for brevity, the word "salmon" will refer to both groups.

APPROPRIATE ROLE OF HATCHERIES

Two guiding principles should be applied to all uses of hatcheries for restoration of naturally-spawning populations.

Use hatcheries only as part of a comprehensive restoration strategy.

A hatchery program should be only one component of a comprehensive rebuilding strategy designed to remove or significantly reduce the human-induced causes of the population's decline (Kapuscinski et al. 1991). Different salmon populations in the Pacific Northwest have experienced different causes of decline, with several causes often acting in concert (Nehlsen et al. 1991). A major problem has been habitat deterioration or loss due to barriers to passage (dams), reduced or altered stream flows, poor water quality, water diversions, destruction of spawning or nursery habitat, increased exposure to competition and predation from native species, or effects of introduced species (Li et al. 1987). Some natural populations which produce relatively low amounts of harvestable surplus have been further depleted by overharvest. Sole focus on a hatchery, no matter how well designed and managed, cannot compensate for all root causes of decline and will not result in sustainable restoration of naturally-spawning populations. This principle echoes the approach recently recommended by the Northwest Power Planning Council (1992) in its Strategy for Salmon.

A medical analogy illustrates the value of this principle. The patient is a salmon population, the symptom is decline, and lack of treatment could lead to death, or extinction. Before even prescribing a treatment to rebuild the population, a good doctor makes a diagnosis consisting of the best possible assessment of causes of decline. Although the diagnosis may not answer all questions about what went wrong, it guides the doctor in choosing the most effective treatment from available options. Effective treatment might include a hatchery program in some cases and not in other cases.

Prescription of a hatchery program as part of a comprehensive restoration effort is reasonable under three scenarios:

1. a temporary hatchery program to increase a depleted population or reestablish an extinct population to self-sustaining status while root causes are being reversed (e.g., while habitat is being restored);

2. a long-term hatchery program where habitat is irreversibly damaged or lost, provided that negative impacts of hatchery fish on other naturally-spawning populations are negligible; and

3. a long-term hatchery program to augment harvest above levels supported by existing freshwater habitat, provided it is feasible to separate hatchery fish from naturally-spawning fish in freshwater habitats and in the fishery.

The first scenario is the best possible role for hatcheries because: (a) hatchery expenses can be terminated when self-sustainability is achieved; and (b) restoration of a self-sustaining population also is a good indicator of improved health of the overall watershed ecosystem. Temporary and less expensive hatchery facilities may work for this scenario. Conditions required for the third scenario, harvest augmentation, will be hard to meet in many cases and would require changes in harvest methods and management. Section 5 of the Strategy for Salmon proposes testing of alternative harvest methods for selective harvest of hatchery fish (Northwest Power Planning Council 1992).

Another potential use of hatcheries for restoration involves release of hatchery fish with the expectation that they will *interbreed* with the depleted, naturally-spawning population and that the resulting mixed population will be managed as one unit. This scenario is sometimes called "supplementation." The merit of this approach is still an open question because such programs have not yet been fully implemented and evaluated. This approach, for example, is planned for new hatcheries in the Yakima subbasin of the Columbia River Basin. To maximize learning about risks, benefits, and desirable modifications, a strong commitment to monitoring and evaluation of this program is imperative. My recommendation is to allow learning to proceed in a small number of carefully chosen cases, such as the Yakima, before considering widespread adoption of this approach.

<u>All hatchery programs must adopt the goal of maintaining existing genetic resources in naturally-spawning and hatchery salmon populations.</u>

Genetic diversity exists among and within salmon populations. It is important because it allows salmon populations to evolve and thus persist far into the future. Sustainable restoration and maintenance of salmon populations can only be achieved if these genetic resources are maintained in perpetuity (Riggs 1990, Kapuscinski 1991). Adherence to this goal will require revision of many current hatchery policies and practices in addition to proper hatchery monitoring and evaluation. General recommendations for revisions and improved coordination among salmon management programs appear in Kapuscinski (1991) and Kapuscinski et al. (1991). Recently, an "Integrated Hatchery Operations Team" initiated development of a uniform hatchery policy for all Columbia Basin fisheries programs (Jerry Bauer, Bonneville Power Administration, Portland, OR, personal communication). The final draft policy must undergo rigorous and independent scientific review to ensure that it is genetically sound and practicable.

Then, all fisheries management agencies operating salmon hatcheries in the Pacific Northwest should be encouraged to adopt the final policy.

ARTIFICIAL PRODUCTION TECHNIQUES AND SYSTEMS, RISK ASSESSMENT, AND MONITORING

Traditional methods and physical facilities for salmon hatchery production need to be revised in order to be compatible with the twin goals of (a) restoring naturally-spawning populations and (b) maintaining existing genetic resources in all affected hatchery and naturally-spawning populations. Hatchery systems should aim to reduce the major limiting factor in freshwater habitats. In many Pacific Northwest cases (outside of Alaska), the major freshwater limitation appears to be depressed production and downstream survival of smolts due to habitat loss and damage. Therefore, appropriate hatchery systems for most restoration cases should involve artificial propagation from fertilized eggs to the smolt stage.

Genetically-sound revisions are needed in hatchery techniques and operations.

My current work on the Yakima/Klickitat Fisheries Project is to develop specific and feasible genetic guidelines for all possible phases of hatchery operations, including adult collection and mating, offspring rearing, fish releases, and related activities (Kapuscinski and Miller in prep., table of contents attached). Scientific peer review and appropriate revision of these draft guidelines must occur before they are implemented and evaluated in new Yakima hatcheries. Some elements of these guidelines, such as how to best mate males and females, are based on well documented biological principles and data. They are immediately and generally appropriate for all hatcheries used in sustainable restoration of naturally-spawning populations. Incentives for their general and coordinated application in the Pacific Northwest are needed.

Captive broodstock programs, where fish are maintained in captivity for an entire life cycle, are expensive and involve increased biological risks compared to traditional salmon culture programs, where only part of the life cycle is in captivity (usually from fertilized egg to sub-adult smolt). They are appropriate as a last resort when a population is dangerously close to extinction (Hard et al. 1992). For example, a captive broodstock program was recently initiated for the endangered Snake River sockeye salmon.

Some revisions of physical hatchery facilities may be needed to accommodate restoration and genetic goals.

Although I am not directly involved with revision of hatchery facilities, I am aware that some changes are necessary to accommodate the twin goals of restoration and genetic conservation. Designs for the Yakima Basin hatchery program, for instance, include (a) improved separation of genetically distinct populations in incubation, fry and smolt rearing units; and (b) establishment of streamside smolt acclimation ponds. Smolt acclimation ponds are intended to improve survival of released smolts and adult homing to desired natural spawning sites. Application of these and other facility modifications requires careful evaluation before considering them for widespread use.

Genetic risk assessment should be conducted on all proposed hatcheries and comprehensive, coordinated monitoring systems implemented for all functioning hatcheries.

Risks of damaging (a) existing genetic resources and (b) long-term persistence of naturally-spawning populations should be assessed during early planning of hatchery programs and before large amounts of money have been spent. Proposed actions with high risk should be identified and altered in order to remove or substantially reduce these risks. The Pacific Northwest currently lacks a uniform protocol for genetic risk assessment of all planned hatcheries. The first review draft of a generic protocol, however, will soon be available from work under the Yakima/Klickitat Fisheries Project. Following revision based on independent scientific review, I recommend creation of incentives for application of the final risk assessment protocol to all planned hatcheries in the region.

Currently, no comprehensive system is in place to monitor salmon hatchery programs (both individually and collectively) for (a) restoration of naturally-spawning populations, and (b) reduction of all genetic risks. To reduce costs and increase learning, a uniform and comprehensive monitoring program should be developed and its implementation coordinated among all Pacific Northwest fisheries agencies with jurisdiction over the same or interacting salmon populations. This recommendation echoes the calls in Section 6.2 of the Strategy for Salmon (Northwest Power Planning Council 1992) for performance standards, independent audits, and impact assessment for all Columbia Basin hatcheries. Finally, results from hatchery monitoring must be regularly evaluated to make appropriate mid-course corrections, even when this may mean termination of a hatchery program because major problems cannot be corrected.

Some pieces of a comprehensive hatchery monitoring system exist or are under development. The Columbia River Basin is rapidly moving towards marking of all hatchery fish, although several concerns must be resolved. This

would make it possible to selectively harvest hatchery fish from mixed stock fisheries, identify stray hatchery fish, and evaluate homing of hatchery fish to desired natural spawning grounds. Under the Yakima/Klickitat Fisheries Project, genetic monitoring guidelines are being developed that will be generally applicable to salmon hatchery programs.

The most commonly used monitoring tool is a method of identifying genetically distinct populations, called protein electrophoresis. This method is increasingly used by state and federal fisheries management agencies to assess catches of different Pacific salmon stocks in mixed stock fisheries. Unfortunately, it cannot distinguish hatchery fish from depressed naturally-reproduced populations in a mixed stock fishery (Craig Busack, Washington Department of Fisheries, Genetics Program, Olympia, WA, personal communication). It is also used to inventory the distribution of distinct populations in freshwater habitats. An example is the 1992 Washington Salmon and Steelhead Stock Inventory, jointly produced by Washington Department of Fisheries, Washington Department of Wildlife, Northwest Indian Fisheries Commission, and Washington Treaty Indian Tribes. Such inventories are required to identify depleted populations and to properly design restoration programs.

Overhaul of the present hatchery system is needed to assist restoration.

A recent genetic analysis of hatchery policies and guidelines in the Columbia Basin (Kapuscinski 1991) revealed tremendous variability among fisheries management agencies in thoroughness and biological quality of their approaches. This finding, which is probably also true for hatchery programs outside of the Columbia Basin, makes it highly unlikely that the present system can successfully restore many naturally spawning populations. In addition to structural and operational changes mentioned in my comments above, two major system-wide changes are needed. First, all fisheries management agencies must improve the biological quality and consistency of their hatchery policies and practices because these have major impacts on sustainability of naturally-reproducing populations. Second, improved coordination is desperately needed among agencies with overlapping responsibilities for the same or interacting natural populations. Coordination should focus on planning, risk assessment, monitoring, evaluation, and mid-course corrections of all hatchery programs.

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GENETIC HATCHERY GUIDELINES

FOR THE

YAKIMA/KLICKITAT FISHERIES PROJECT

Preliminary Draft

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GENETIC ANALYSIS OF POLICIES AND GUIDELINES FOR SALMON AND STEELHEAD HATCHERY PRODUCTION IN THE COLUMBIA RIVER BASIN

EXECUTIVE SUMMARY

Prepared for

The Northwest Power Planning Council

[Agreement 90-037]

Prepared by

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March 15, 1991

GENETIC ANALYSIS OF POLICIES AND GUIDELINES FOR SALMON AND STEELHEAD HATCHERY PRODUCTION IN THE COLUMBIA RIVER BASIN

EXECUTIVE SUMMARY

Purpose

This report presents a genetic analysis of existing agency policies, guidelines, rules, or plans[1] related to hatchery production of salmon and steelhead in the Columbia River Basin. Agencies covered in this analysis include the U. S. Fish and Wildlife Service (FWS), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), and Washington Department of Wildlife (WDW).

Features of the Analysis

Policies and guidelines were evaluated primarily for their effectiveness in conserving genetic resources found in naturally reproducing stocks. Evaluations were based on three related concerns:

1. Improperly managed hatchery programs may alter the genetic resources and life history patterns of hatchery stocks.

2. For many hatchery programs, direct or indirect genetic interactions between hatchery and naturally reproducing stocks are possible.

3. Alterations of genetic resources and life history patterns of hatchery stocks may threaten their fitness and the long-term perpetuation of naturally reproducing stocks with which they genetically interact.

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[1] For brevity in this report, "policy(ies)" refers to policies, rules, or plans; "document(s)" refers to policies, rules, plans, or guidelines.

Agency documents were compared for their treatment of five factors. These factors include:

1. definitions of key genetic terms and stock categories;
2. genetic goals of hatchery programs;
3. hatchery broodstock and rearing guidelines;
4. indirect genetic impacts of hatchery fish; and
5. genetics research and monitoring.

Comparisons of Agency Documents

Foremost protection of genetic resources in naturally reproducing populations appears to be the intent of all agencies. Most agencies have a written statement of such a goal. Achievement of this goal, however, is greatly threatened by the tremendous variability among agencies in thoroughness and quality of their treatment of the five factors listed above. Conserving genetic resources of both naturally reproducing and hatchery stocks is highly dependent on proper handling of these factors. Yet no agency has considered them all in its written policies and guidelines (Table 1). Factors which are considered are treated with different degrees of completeness. A number of specific policies or guidelines may be inconsistent with the goal of conserving genetic resources in fish stocks. The body of this report presents a case-by-case examination of each factor in the suite of documents for each agency.

Recommendations for Improvement of Agency Policies and Guidelines

General recommendations are made for the five factors affecting conservation of genetic resources in salmon and steelhead stocks. A common theme of these recommendations is the paramount need for greater consistency in approaches of different agencies. Recommendations are summarized below.

Definitions of Key Concepts

A. Append definitions of genetic resources that are affected by management actions to all written policies and guidelines regarding salmon and steelhead hatchery production in the Columbia Basin. Specifically address polygenic variation for life history traits because long-term perpetuation of fish stocks is largely dependent on maintenance of this type of genetic variation.

B. Append biologically sound definitions and practicable assignment criteria for stock categories to all written policies and guidelines on salmon and steelhead hatchery production in the Columbia Basin.

C. Define other frequently used terms in order to clarify the intent of a particular policy or guideline.

D. Develop consistent definitions and assignment criteria for agencies whose actions impact the same or genetically interacting stocks.

Genetic Goals

A. Initiate all documents addressing hatchery production with a direct commitment to the following genetic conservation goal (Riggs 1990): maintain genetic resources of salmon and steelhead in native, naturalized, and artificially propagated populations with no avoidable and irreversible losses of genetic diversity resulting from management interventions or inactions.

B. Consistent with this goal, make conservation of existing wild populations a first priority (Allendorf et al., 1990).

C. For agencies whose actions impact the same or genetically interacting stocks, establish a consistent approach to meeting this genetic conservation goal by adoption of the production framework delineated in Riggs (1990) and clarified in Allendorf et al. (1990).

Hatchery Broodstock and Rearing Guidelines

A. Establish written guidelines for maintaining similar genetic resources and life history patterns in hatchery broodstocks and wild or natural stocks with which they may genetically interact.

B. Establish consistency in guidelines of different agencies managing stocks in the Columbia River Basin.

C. Provide written direction on donor stock source, adults mated, fertilization protocol, rearing practices, and size of donor stock remaining for natural reproduction:

1. *Donor stock source*:
Hatchery stocks should be founded from carefully chosen donor populations which have genetic resources and life history patterns similar to the wild or natural stocks with which they may genetically interact (Allendorf et al. 1990).

2. *Adults mated*:
Prevent founder effects by ensuring that hatchery founders represent a statistically significant sample of the donor stock's gene pool.

In every breeding season, maintain the largest effective population size possible under the operating constraints of a particular hatchery by: breeding as many parents as is feasible; mating at least one male per female in daily matings; whenever possible in daily matings, splitting gametes of the least numerous sex into subsets and crossing each subset with gametes from a different individual of the more numerous sex; and minimizing variation in family size at the time of mating.

Avoid intentional and unintentional artificial selection in collection of parents from donor stock and from adults returning to the hatchery.

3. *Fertilization protocol*:
Maintain high effective population size and minimize hatchery-induced variation in family size by using the milt from an individual male to fertilize the eggs of an individual female (Withler 1988). In cases where effective population size can be increased by breeding more than one male per female, use the milt of a different male to fertilize each separate subset of eggs from an individual female. In situations where egg supply is severely limited or male fertility is highly variable, pool the milt from overlapping pairs of males (A and B, B and C, C and D, etc.) and immediately fertilize eggs of individual females (Gharrett and Shirley 1985).

4. *Rearing practices*:
Reduce artificial selection during incubation, rearing, and in fish releases.

If artificial selection programs are planned or practiced, evaluate if they are consistent with genetic conservation goals.

5. *Size of donor stock remaining to reproduce naturally*:
Ensure that numbers of individuals remaining to reproduce naturally are sufficiently large to prevent loss of genetic variation in the donor stock.

Prevent selective removal of adults to ensure existing life history patterns of the donor stock are conserved in individuals remaining to breed naturally.

Indirect Genetic Impacts of Hatchery Fish

A. Institute policies and guidelines on indirect genetic impacts of hatchery stocks on wild and natural stocks. Consider impacts due to: ecological interactions, such as competition for limited resources in natural habitats; and reproductive overfishing in mixed-stock fisheries.

B. Develop guidelines for case-by-case determination of allowable numbers of hatchery fish released in order to minimize indirect genetic impacts.

Genetics Research and Monitoring

A. Develop evolutionarily valid criteria for assigning wild or natural stock status to naturally reproducing fish populations.

B. Monitor levels of genetic variation for life history traits in hatchery stocks.

C. Monitor genetic resources and life history patterns of wild or natural stocks with which hatchery stocks may genetically interact.

D. Determine susceptibility of naturally reproducing stocks to indirect genetic impacts from hatchery stocks due to ecological interactions.

E. If intentional selection programs are used, undertake carefully monitored small-scale experiments before considering operational implementation.

F. Develop a database of life history patterns, genetic variation, and population dynamics of naturally reproducing and hatchery stocks.

Table 1. Comparison of agency documents reviewed for presence (+) or absence (-) of factors influencing conservation of genetic resources in fish stocks. Presence does not imply uniform quality nor appropriate approach in handling of these factors.

Factor	Presence or Absence in Agency Documents					
	FWS	FWS-3[1]	IDFG	ODFW	WDF	WDW
Genetic Definitions	-	-	-	+	+	-
Stock Definitions	+	-	+	+	-	-
Genetic Goals Stated	+	+	+	+	-	-/+[2]
Broodstock and Rearing Guidelines:						
- Donor stock source	-/+[3]	+	+	+	+	-/+[3]
- Adults mated	+	+	-	+	+	-
- Fertilization protocol	+	-	-	-	+	-
- Rearing practices	-/+[3]	+	-/+[4]	-	+	-
- Size of remaining donor stock	-/+[3]	-	+	-	-	-
Indirect Genetic Impacts of Hatchery Stocks	-/+[3]	+	+	+	-	+
Research & Monitoring	+	+	-	+	+	-

1. FWS-3, a "Fish Gene Resource Protection Policy" is considered separately because it is currently in draft form (see Appendix I).

2. This factor doesn't appear directly in the policies reviewed but is implied (see section 2.5 of main report).

3. Aspects of this factor appear in some but not all documents which should address it.

4. Handling of this factor is problematic (see section 3.3.3 of main report).

GENETIC ANALYSIS OF POLICIES AND GUIDELINES FOR SALMON AND STEELHEAD HATCHERY PRODUCTION IN THE COLUMBIA RIVER BASIN

Prepared for

The Northwest Power Planning Council

[Agreement 90-037]

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GENETIC ANALYSIS OF POLICIES AND GUIDELINES FOR SALMON AND STEELHEAD HATCHERY PRODUCTION IN THE COLUMBIA RIVER BASIN

Purpose

The purpose of this report is to present a genetic analysis of existing agency policies, guidelines, rules, or plans[1] related to hatchery production of salmon and steelhead in the Columbia River Basin. The analysis addresses definitions of key concepts, genetic goals of hatchery programs, hatchery broodstock and rearing guidelines, indirect genetic impacts of hatchery fish, and genetics research and monitoring. Direct genetic interactions of hatchery fish with wild and natural fish, and effectiveness of hatchery programs in meeting a genetic conservation goal are considered throughout the analysis. Agency documents are compared for similarities, differences, and omissions. Recommendations are made for improvements, particularly to achieve greater consistency in approaches of different agencies.

Documents Included in the Analysis

Appendix I lists the documents reviewed and their abbreviations. Documents were provided by the Northwest Power Planning Council (except for FWS-3, FWS-4, FWS-5, FWS-6, and FWS-7, which were solicited directly from the agency). Agencies covered in this analysis include the U.S. Fish and Wildlife Service (FWS), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), and Washington Department of Wildlife (WDW).

1. DEFINITIONS

Discussions of management policies and specific guidelines for hatchery production of salmon and steelhead in the Columbia River Basin require frequent use of two types of terms: (1) gene resources to be conserved or otherwise managed; and (2) categories of fish stocks that are used in hatchery production or may genetically interact with hatchery-released

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fish. Explicit definitions and realistic assessment criteria for these terms are of paramount importance. When definitions and assessment criteria are missing from an agency's hatchery-related policy or guidelines, the intent of the document is ambiguous and the potential for having inadvertent errors in biological concepts or management actions is increased. Clearly stated definitions and assessment criteria serve several purposes:

1. They ensure that the intended meaning and implementation of hatchery policies and guidelines are consistent with the agency's desired management goals.

2. They clarify the purpose of and rationale for hatchery policies and guidelines, thus greatly reducing confusion and criticism from agency personnel, user groups, or other parties interested in salmon or steelhead resources.

3. They facilitate evaluation of the biological appropriateness of hatchery-related policies and guidelines.

4. They help to identify the types of data needed for monitoring effectiveness in achieving objectives stated in hatchery-related policies and guidelines.

5. They facilitate efforts to improve consistency in genetic goals among agencies involved in salmon or steelhead hatchery production in the Columbia River Basin.

1.1 Genetic Definitions in Agency Documents

Genetic definitions are uncommon in the documents reviewed. ODFW-1 and WDF-1 contain some genetic definitions. They both lack criteria for assessing genetic resources of hatchery or wild and natural stocks, although WDF-1 presents some of the conceptual background. ODFW-1 contains a general definition for "genetic resources". The definition is broad enough that it can be interpreted to encompass all genetic resources recommended for definition (see section 1.2.1 below). More detailed definitions would clarify the intent and interpretation of this document. WDF-1 contains a glossary of some genetic terms. Important gene resources discussed in section 1.2.1 are explained in the body of the document, although the glossary doesn't contain concise definitions for all of them.

Documents of other agencies refer to genetic resources of stocks with a variety of undefined terms. IDFG apparently also uses WDF-1, a document which contains genetic definitions (Willa Nelson, NWPPC, personal communication); but there is no written reference to WDF-1 or its definitions. Frequently used terms lacking definition include: genetic characteristics, genetic dilution, genetic diversity, genetic integrity, genetic makeup, gene resources, genetic status, and genetic traits. Criteria for assessing the status of genetic resources in stocks are also missing. Appendix III summarizes the identity and location of these key undefined terms in specific documents.

1.2 Improvement of Genetic Definitions

A. Append definitions of genetic resources affected by management actions to all written policies and guidelines regarding salmon and steelhead hatchery production in the Columbia Basin.

B. Develop consistent definitions for agencies whose actions impact the same or genetically interacting stocks.

Gene resources discussed below provide a starting place for developing practicable and biologically relevant definitions. Consistency of definitions among agencies in the Columbia Basin is encouraged, as this will facilitate coordinated development and achievement of genetic goals for hatchery programs (section 2).

1.2.1 Genetic resources to define

Genetic definitions should address at least the following terms because: (a) they describe the genetic resources of fish stocks that may be affected by hatchery programs; and (b) these genetic resources greatly influence the fitness of individual fish, evolutionary potential of an entire stock, and chances of long-term perpetuation of fish stocks and species (section 2.6).

A. Classes of genes - include **structural genes** (coding for a protein product), **regulatory genes** (control the functioning of structural genes), and **genes coding for molecules involved in protein synthesis** (e.g., a gene for ribosomal RNA). All three classes of genes are important for the fitness of individual fish. Adaptive evolution of an entire fish stock depends mostly on variability in structural and regulatory genes.

B. Types of genetic variation - include variation for **qualitative traits** (under single gene control) and **quantitative traits** (controlled by many genes, polygenic). Qualitative traits are described qualitatively rather than by a measurement. Examples of qualitative traits are polymorphic proteins detected by protein electrophoresis; variation in these polymorphic proteins are often used for fish stock identification. Quantitative traits vary in meristic or continuous fashion. Examples of quantitative traits are life history and performance traits. Because the majority of adaptive evolution in a population is based upon changes in quantitative traits rather than in qualitative traits (Lande and Barrowclough 1987), maintenance of genetic variation for quantitative traits is required to ensure long-term perpetuation of fish stocks.

C. Hierarchical organization of genetic variation - includes variation in alleles **within an individual's genotype**, genetic variation **between individuals within stocks**, and genetic variation **between stocks within a species**. These three levels of genetic variation constitute the entire genetic diversity of a species. Hatchery-related policies and guidelines must be concerned with all three levels of genetic diversity because adaptive evolution and long-term persistence of the species depends on them all.

Some genes **within stocks** may be organized as coadapted gene complexes. These are combinations of genes occurring in many individuals because they have functioned well together over many generations of natural evolution in the local environment. Occurrence of coadapted gene complexes and their relevance in environments highly altered by human activities (e.g., many parts of the Columbia River Basin) is not yet well documented in salmon and steelhead (Allendorf et al. 1990).

1.3 Stock Definitions in Agency Documents

Documents FWS-2, IDFG-1, and ODFW-1 contain some definitions of stock categories. Definitions from these three documents fit under four possible headings based on different breeding histories of ancestors, particularly on the degree to which interbreeding with hatchery-released fish may have occurred: (1) hatchery stocks, (2) wild stocks, (3) natural stocks, and (4) transplanted stocks. Using these four headings, Appendix II compares the definitions found in the three documents. Definitions of hatchery and transplanted stocks may overlap because a hatchery stock may originate from a transplanted stock or from local stock. The category, natural stocks, is meant to be intermediate between wild and hatchery stocks. Appendix IV defines *this report's usage* of "wild" and "natural" stocks.

There is little consistency in stock definitions found in FWS-2, IDFG-1, and ODFW-1. Different conditions for breeding history have been used to distinguish between hatchery stocks, wild stocks, or natural stocks. Note, for example, the differences under the heading, hatchery stocks, in Appendix II. For FWS, a stock fits under this heading only if fish have been held and fed in a hatchery for more than two generations. A contrasting approach is taken by ODFW, which places fish under this heading if they are spawned and/or reared under artificial conditions regardless of the history of the parent stock. The IDFG definition most resembles that of ODFW by simply stating that hatchery fish are produced in hatcheries or other artificial facilities; however the issue of parental history is not explicitly addressed. Similar differences exist in definitions fitting under the heading, wild stocks. FWS-2 doesn't recognize an intermediate category of natural stocks while ODFW-1 and IDFG-1 have similar definitions. ODFW-1 is the only document that defines the category, transplanted stocks.

Definitions for categories of stocks are not included in any WDF and WDW documents reviewed. Appendix III summarizes the identity and location of undefined stock terms. None of the documents reviewed give criteria for data to use in assigning a particular fish or stock to a category.

1.4 Improvement of Stock Definitions

A. Append biologically sound definitions and practicable assignment criteria for stock categories to all written policies and guidelines on salmon and steelhead hatchery production in the Columbia Basin.

B. Develop consistent definitions and assignment criteria for agencies whose actions impact the same or genetically interacting stocks.

Genetic concerns about hatchery stocks are that they may: (a) lose genetic variation and develop different gene combinations and life history patterns compared to wild or natural stocks; and (b) reduce fitness and long-term perpetuation of wild and natural stocks with which they may genetically interact. Much uncertainty exists about the hatchery conditions, natural environmental conditions, and ancestral breeding histories under which these concerns are legitimate or unwarranted (Allendorf et al. 1990, Kelly et al 1990, Skaala et al. 1990). Properly designed and long-term monitoring studies would help remove some of

these uncertainties (section 5). Meanwhile, fisheries agencies are faced with the reality of having to manage these resources in the face of current uncertainties. Many hatchery policies and guidelines therefore contain components designed to minimize negative impacts on wild and natural stocks. Given the long history of hatchery fish releases and stock transfers, discussions of genetic concerns inevitably involve use of terms such as hatchery stock, wild stock, natural stock, etc. Rational formulation and implementation of policies addressing these concerns depend on having: (a) biologically relevant and clearly stated definitions; (b) practicable criteria for assignment of particular fish to each category; and (c) consistent definitions among agencies impacting the same or genetically interacting stocks.

1.5 Improvement of Other Definitions

A. Define other frequently used terms in order to clarify the intent of a particular policy or guideline.

Appendix III lists the identity and locations of these terms.

2. GENETIC GOALS OF HATCHERY PROGRAMS

Fisheries agencies have two basic options for maintaining or increasing abundance of salmon and steelhead stocks in the Columbia River Basin. First, they can manage factors that directly and indirectly affect natural production. Natural production involves adults reproducing in natural environments, followed by survival of their offspring until recruitment to the fishery or escapement to spawning grounds. Second, they can release hatchery-produced fish and manage factors influencing their survival. Genetic interactions of naturally and hatchery produced fish are possible. Under certain conditions, these interactions may detrimentally alter genetic resources of wild or natural stocks, leading to declines in their abundance and long-term persistence in natural environments. Certain conditions in hatchery programs also may detrimentally alter genetic resources of hatchery stocks, leading to declines of their fitness in natural environments. Genetic goals are therefore an expected component of a biologically sound agency document for the use of hatcheries in maintaining or increasing stock abundance.

2.1 Genetic Goals in Agency Documents

Documents of FWS, IDFG, and ODFW contain identifiable genetic goals for hatchery production. While not directly stated, goals are implied in some policy statements of WDW documents. WDF documents lack genetic goals.

2.2 Genetic Goals in FWS Documents

FWS-1 contains the following statements relevant for a genetic goal:

a. "Carry out broodstock activities in a manner that will preserve or optimize the genetic integrity of the stocks involved."

b. "Strive to provide and/or utilize gametes and fry of the species and strain that best meet the biological requirements of the specific resource management programs."

c. "Enter into trades, exchanges, or agreements with State or other Federal agencies, or foreign governments to obtain fish or eggs of the desired strain."

While statement (a) is a genetic goal, it's intent is vague for two reasons. First, the expression "preserve or optimize genetic integrity" is undefined (Appendix III). Second, it is unclear if "stocks involved" includes wild and natural stocks that may genetically interact with hatchery fish. Statement (b) may be relevant to genetic goals, depending on the intended meaning of "biological requirements", which is undefined. Statement (c) permits stock transplantations with no recognition that this may lead to introduction of very different genetic material into the recipient stock and no provision for conditions under which this is warranted or unwarranted. Well-performing wild and natural stocks may be negatively impacted by such introduction of new genetic material. Allendorf et al. (1990) outline two situations in which introductions of new genetic material may be warranted.

FWS-3, currently only in draft form, addresses some ambiguities of FWS-1. It's foremost goal is protection of "gene resources" of "native populations", including protection of genetic variation in hatchery stocks that may genetically interact with native fish. Also, it outlines steps for evaluation of potentially detrimental genetic impacts of stock transplantations.

A genetic goal may be inferred in FWS-4 for Region 1 (covering the Columbia River Basin). It calls for favoring "wild fish strains over hatchery strains" and emphasizing maintenance and restoration of "natural-occurring runs of fish."

2.3 Genetic Goals in IDFG Documents

This agency's genetic goals closely resemble those of FWS-3. IDFG-1 has two relevant statements. The foremost priority is "preservation of desirable genetic characteristics of wild fish." Consistent with this priority, "hatchery production programs will be managed in a manner that minimizes adverse effects on the quantity and quality of natural production of anadromous fish." In keeping with this policy, the draft Policy Plan for 1990-2005 (IDFG-3) states "the Department will strive to maintain genetic integrity of wild native stocks when using hatchery supplementation." The draft Fisheries Management Plan for 1990-1995 (IDFG-4) makes a similar statement (page 23).

2.4 Genetic Goals in ODFW Documents

The Wild Fish Management Policy in ODFW-1 is similar to IDFG policy and the draft FWS-3. It states that "protection of genetic resources shall be the priority in the management of wild fish." Also, because "interbreeding of hatchery fish with wild fish pose risks to conserving and utilizing the genetic resources of wild populations", alternative strategies are presented to limit these genetic risks. Finally, it mandates development of a gene conservation policy.

The Natural Production Policy in ODFW-1 refers to the need to "conserve stock fitness and life history characteristics" in order to "protect and promote natural production of indigenous, and where desirable, introduced fishes." This policy doesn't clearly address the relationship of hatchery programs to the protection of natural production. Conditions for "desirable" use of introduced fishes are not defined. Except for ambiguities associated with these omissions, this policy generally concurs with the Wild Fish Management Policy.

2.5 Genetic Goals in WDW Documents

While WDW policies lack a clear statement of genetic goals for hatchery production, a few statements imply their existence. These include:

"minimize genetic and competitive impacts of hatchery fish on wild stocks whenever feasible" (WDW-1);

"select a suitable wild broodstock for the rehabilitation program. This should be the wild stock indigenous to the river system" (WDW-2 and -3); and

"ensure that there will be no adverse impacts to existing fish populations" (WDW-6).

WDW-1, WDW-2 and WDW-3 represent alternative strategies for hatchery production. Lack of an umbrella goal statement weakens these policies. It is unclear how the choice is made between hatchery releases to increase wild/natural spawning escapements (WDW-2) or to utilize unused or underseeded rearing habitat (WDW-3). A policy for choosing among alternative hatchery strategies may appear in documents in preparation addressing management principles and a steelhead plan (Bob Gibbons, WDW, personal communication).

2.6 Improvement of Genetic Goals

A. Initiate all documents addressing hatchery production with a direct commitment to the following genetic conservation goal (Riggs 1990): maintain genetic resources of salmon and steelhead in native, naturalized, and artificially propagated populations with no avoidable and irreversible losses of genetic diversity resulting from management interventions or inactions.

B. Consistent with this goal, make conservation of existing wild populations a first priority (Allendorf et al., 1990).

C. For agencies whose actions impact the same or genetically interacting stocks, establish a consistent approach to meeting this genetic conservation goal by adoption of the production framework delineated in Riggs (1990) and clarified in Allendorf et al. (1990).

Thorough explanation of the foremost need for this genetic conservation goal is presented in Riggs (1990). To reiterate, *sustainable maintenance or increases in salmon and steelhead productivity in the Columbia River Basin can only be achieved if the genetic resources required for all forms of production, present and future, are maintained in perpetuity.* Taken together, Riggs (1990) and Allendorf et al. (1990) provide a framework for carrying out this genetic conservation goal by delineating six guiding principles, six management opportunities existing in the Columbia River Basin (four involving hatchery production), and three production approaches (two involving hatchery production).

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3. BROODSTOCK AND REARING GUIDELINES

Achievement of a genetic conservation goal requires delineation of genetic guidelines for hatchery broodstocks and rearing practices. Broodstock management and rearing activities may alter genetic resources and life history patterns of hatchery stocks. In turn, hatchery-released fish may alter genetic resources and life history patterns of wild or natural stocks via interbreeding. Wild stocks may be genetically altered if excessive numbers of adults are removed to supply gametes for hatchery stocks (section 3.7.5). Indirect genetic impacts are also possible if large numbers of hatchery fish enter into behavioral and ecological interactions with wild or natural stocks (section 4). Hatchery-related practices that may impact gene resources and life history patterns include:

a. donor stock source;
b. adults mated;
c. fertilization protocol;
d. rearing practices; and
e. size of donor stock remaining for natural reproduction.

3.1 Broodstock and Rearing Guidelines in Agency Documents

Agency documents vary greatly in their consideration of hatchery-related practices. Specific guidelines are uncommon and their quality is highly variable. No agency has written guidelines for all five practices listed above that may impact genetic resources and life history patterns of hatchery, wild, and natural stocks.

3.2 Guidelines in FWS Documents

Two national-scope documents, FWS-1 and FWS-2, are silent on all hatchery practices important for a genetic conservation goal. The possibility of developing such guidelines is suggested, however, by statements about responsibilities of broodstock hatchery managers to develop and maintain general broodstock management guidelines which "may require a genetics plan, spawning plan, broodstock replacement plan, disposal plan, etc." FWS may address guidelines for some hatchery practices in case-by-case agreements signed with specific state or native American fisheries management agencies (Tom Sheldrake, FWS, personal communication). For example, the Warm Springs National Fish Hatchery is operated under an agreement between FWS and the Confederated Tribes of the Warm Springs Indian Reservation; some relevant hatchery practices are addressed for this hatchery in FWS-6 (discussed below).

Hatchery practices are partly covered in the draft FWS-3. **Donor stock source** is only indirectly addressed by discouraging intentional transplantation of fish. **Fertilization protocol** and **size of donor stock remaining** for natural reproduction are not discussed. **Adults mated** and **rearing practices** are partly addressed by the following statements:

"The effective population number of broodstock shall be sufficient for fish reared in, imported to, or exported from hatcheries to preclude undesirable genetic changes."

"Genetic engineering and selective breeding, other than that resulting in sterile hatchery fish or designed to mitigate hatchery induced genetic changes, shall be avoided where there is risk of adversely affecting native populations."

FWS-5, a memorandum specific to Region 1, contains broodstock spawning, egg incubation, and egg handling guidelines. It partly covers genetic aspects of only two categories of hatchery practices. **Adults mated** are addressed by recommending a spawning ratio of one female with one male "when possible" and a minimum spawning population size of 200 males and 200 females, while noting that "the more individuals spawned however, the lower will be the incidence of inbreeding." Advice for **fertilization protocol** is to fertilize eggs from a single female with milt from only one male. This advice is consistent with recent research showing unequal contribution of males if sperm is pooled prior to fertilization (section 3.7.3). Finally, single female egg incubation is strongly encouraged for disease control. Such incubation could also benefit conservation of genetic variation in hatchery stocks if it became the first step in an overall program of identifying separate families in a breeding season (reasons presented in section 3.7.2).

FWS-6 was provided as an illustrative example of case-by-case guidelines for a hatchery operated by FWS (Region 1) under agreement with another agency responsible for the fishery resource. While this particular example partly covers **donor stock sources**, **adults mated**, and **rearing practices**, complete coverage of all practices with potential genetic impacts is lacking when the hatchery-specific FWS-6 is evaluated together with the other reviewed FWS documents of regional or national scope. **Donor stock source** is appropriately restricted to fish occurring in the Warm Springs River, the same water body into which hatchery fish are released. To keep hatchery fish genetically similar to naturally-reproducing fish, at least 10% of the hatchery broodstock in every breeding season must be of "wild origin" (determined via fin-clipping of all hatchery releases). Such a strategy is appropriate for the stated objective, but genetic rationale for the 10% minimum is not given. **Adults mated**

are partly considered by requiring their collection from throughout the run and their spawning to be at random. Only one aspect of **rearing practices** is indirectly addressed by discussion of plans to initiate volitional releases and use of passive fish graders for separating fall (larger) from spring (smaller) release fish. This approach would also reduce sources of unintentional artificial selection at the time of release (section 3.7.4), thus increasing chances of keeping similar genetic resources and life history patterns in hatchery and wild fish. Size of **donor stock remaining** for natural reproduction is addressed by setting a healthy minimum natural escapement of 1000 "wild fish", based on an estimate that 1250 adults are "needed to maintain maximum wild production."

3.3 Guidelines in IDFG Documents

Fertilization protocol is not covered in IDFG documents reviewed, although IDFG hatcheries apparently use WDF-2 (Willa Nelson, NWPPC, personal communication) which contains some fertilization guidelines (section 3.5.3). Discussions of **donor stock source, adults mated,** and **size of remaining donor stock** are spread among IDFG-2 and two subsections of IDFG-1. Relevant clauses are summarized below.

3.3.1 Donor Stock Source (IDFG-2)

"Artificial supplementation will utilize indigenous stocks whenever possible."

"Upon loss of ability to propagate indigenous stocks, the following inherent and behavioral characteristics of potential donor stocks will be considered (not necessarily in priority order)."

Items (a-f) in the list after this last statement follow the approach of matching the gene resources and life history patterns of hatchery broodstocks to the indigenous populations with which they may genetically interact. Items (g) and (h), however, contradict this approach by allowing differences in migration timing or size of mature fish of donor stocks when such differences would enhance a fishery. Potential impacts of these differences on genetic resources and sustainability of naturally reproducing stocks are not addressed.

3.3.2 Adults Mated (IDFG-1)

This factor is not clearly addressed. One statement in the harvest management section of IDFG-1 (page 48) is partly relevant:

"whenever possible, we will continually integrate our hatchery and naturally spawning broodstock to maintain a hatchery stock which is capable of successfully surviving through natural production."

3.3.3 Rearing Practices (IDFG-1)

The following policy is relevant to rearing practices:

"Hatchery production goals will be set and manipulated by water temperatures, feeding rates, and general hatchery practices to produce and plant smolts of a size which has produced the highest percentage of returning adults in test programs."

Currently, target smolt sizes are similar to natural smolt size for chinook salmon and larger than natural smolt size for steelhead (Steve Yundt, IDFG, personal communication). Maintenance of naturally existing genetic variation for smolt size, a quantitative trait, is important to ensure adaptive evolution and long-term perpetuation of a stock (section 1.2.1.B). Targeting one smolt size may cause inadvertent reduction in genetic variation for this trait and genetically correlated life history traits, thus jeopardizing sustainability of high adult return rates in future generations. This practice therefore warrants careful review. A statement on page 9 of IDFG-1 acknowledges that "hatchery selection", including "accelerated rearing" could eventually pose a threat to stock persistence, particularly if timing, age composition, or fecundity of runs are altered.

3.3.4 Size of Remaining Donor Stock (IDFG-1)

This issue is addressed by mandating that no more than two-thirds of a natural spawning run will be trapped to build hatchery broodstock in order to leave the remaining third for natural reproduction. The use of one minimum value for all natural spawning runs is a rough estimate, with no clear underlying rationale (Steve Yundt, IDFG, personal communication). Differences in historical patterns of genetic variation and population dynamics of different natural runs may dictate different minimum values in order to conserve their genetic resources and life history patterns.

3.4 Guidelines in ODFW Documents

The Wild Fish Management component of ODFW-1 mandates management of hatchery broodstocks so that either: (a) interbreeding with wild populations is impossible; (b) where interbreeding of released hatchery fish and wild fish is possible, hatchery fish "are maintained to be genetically similar to the wild population"; or (c) except for fish genetically similar to the wild population, hatchery fish "that spawn at the same time

and place as the wild population shall comprise no more than 10% of the total number of naturally spawning fish." Biological rationale for the 10% value and its application to genetic conservation for all naturally spawning stocks is unapparent.

Operating principles for keeping hatchery fish genetically similar to wild fish briefly consider **donor stock source** and **adults mated. Rearing practices, size of remaining donor stock** and **fertilization protocols** are not addressed at all, although they could be included in a gene resource conservation policy currently in preparation (Mark Chilcote, ODFW, personal communication).

3.4.1 Donor Stock Source

This issue is briefly addressed without referring to specific guidelines:

"Use only hatchery fish that originated from the wild population"; and "incorporate naturally produced fish in the broodstock in every generation."

3.4.2 Adults Mated

Genetic concerns are briefly addressed without referring to specific guidelines:

"Avoid random and nonrandom genetic change due to failure to maintain a representative sampling of the genes within a population."

3.5 Guidelines in WDF Documents

WDF documents give guidelines for **donor stock sources, adults mated, fertilization protocols,** and **rearing practices.** WDF-1 provides the conceptual background and general guidelines. WDF-2 and WDF-3 give more specific guidelines. Owing partly to the writing style, much of the text in WDF-2 is hard to follow and rationale for some advice is ambiguous. **Size of remaining donor stock** is not discussed in any WDF document.

3.5.1 Donor Stock Source

WDF-3 lists allowable donor stocks for various salmon hatcheries, with a preamble implying an approach of keeping hatchery stocks similar to natural or wild stocks with which they may genetically interact. Chapter 1 of WDF-1 directly calls for the same approach. It also recommends maintaining separate identity of stocks in situations where more than one stock is propagated at a hatchery.

3.5.2 Adults Mated

Artificial selection: WDF-2 and chapter 1 of WDF-1 call for maintaining the genetic diversity of the donor stock in the hatchery stock by avoiding artificial selection unless "specifically directed to do so." WDF-1 explains that gametes should be collected from representative portions of each run, based on return date, size and age. WDF-2 goes on to specify that jacks should be included in the spawning population "at a level of 2% of the total number of both male and female fish spawned that day." While this is explained to offset the distortion in frequency of jacks caused by fishing gear selectivity and hatchery rearing conditions, rationale for a constant value of 2% in all cases is missing. Adherence to one value may be flawed for genetic conservation and long-term stock perpetuation.

Neither document gives a policy for specific conditions which warrant intentional selection, although WDF-1 appropriately urges definition of goals and follow-up assessment of effects of any selection program. To be consistent with a genetic conservation goal, any directed selection program should begin with small-scale experimentation and careful monitoring (sections 3.7.4.B and 5).

Number of parents: WDF-1 advises a minimum size of 200 parents when "the number of returning adults is not a limiting factor." This recommendation of one minimum value needs to be balanced by advice to maximize the number of parents, taking into consideration the operating constraints of a particular hatchery (section 3.7.2.A) and the demographics of the donor stock (section 3.7.5).

Sex ratio: WDF-1 advises a 1:1 sex ratio with no provision for exceptions. Yet WDF-2 recommends a male to female ratio of 1:3 when: the number of available parents is not limiting, more than 0.5 million eggs will be taken on a given day, and the egg surplus will be shipped to another facility. Justification for this advice is not provided. It is flawed in terms of genetic conservation and long-term sustainability of stocks involved (section 3.7.2.A).

3.5.3 Fertilization Protocol

WDF-1 and WDF-2 caution against sequentially adding milt from different males to a lot of eggs from several females because this has been shown to lead to unequal sex ratios. Both documents therefore recommend pooling milt from a number of males in a separate container, and then fertilizing

egg lots with this mixture. Neither document addresses unequal sex ratio problems associated with such pooling of milt (section 3.7.3).

3.5.4 Rearing Practices

WDF-1 cautions against selection during rearing by advising that conditions be "as uniform as possible for all groups of fish." No guidelines are given about non-random culling of individuals from incubators and rearing tanks, a possible source of inadvertent artificial selection (sections 1.2.1.B and 3.7.4). Artificial selection of smolts is permitted, but only after "the majority of each group shows signs of smoltification" to compensate for sex-related differences in growth rate. No WDF document delineates conditions which warrant such selection of smolts (section 3.7.4).

3.6 Guidelines in WDW Documents

WDW documents briefly refer to **donor stock** sources but are silent on guidelines for **adults mated, fertilization protocol, rearing practices,** and **size of remaining donor stock.** A document in preparation on genetic conservation and a management program for hatchery broodstock operations (John Kerwin, WDW, personal communication) may include guidelines for these practices.

3.6.1 Donor Stock Source

WDW-2 and WDW-3 advise use of "wild stock indigenous to the river system", and, when this is impossible, consideration of "other stocks from nearby streams of similar size and type." Guidelines for donor stock sources are vague in WDW-1 and WDW-6, although the former document suggests strategies to minimize interbreeding of hatchery-released fish with wild stocks.

3.7 Improvement of Hatchery Broodstock and Rearing Guidelines

A. Establish written guidelines for maintaining similar genetic resources and life history patterns in hatchery broodstocks and wild or natural stocks with which they may genetically interact.

B. Provide written direction on donor stock source, adults mated, fertilization protocol, rearing practices, and size of donor stock remaining for natural reproduction.

C. Establish consistency in guidelines of different agencies managing stocks in the Columbia River Basin.

3.7.1 Donor Stock Source

Hatchery stocks should be founded from carefully chosen donor populations which have genetic resources and life history patterns similar to the wild or natural stocks with which they may genetically interact (Allendorf et al. 1990).

IDFG and possibly WDW permit an alternative approach of using intentionally different hatchery stocks, along with methods to minimize their interbreeding with wild and natural stocks. To ensure compatibility with a genetic conservation goal, such an approach requires carefully designed monitoring of (a) frequency of interbreeding and (b) incidence of major behavioral or ecological interactions with wild and natural stocks that may lead to indirect genetic impacts (section 4). Releases of large numbers of sterile hatchery fish, for example, would require monitoring to ensure that the majority of individuals are indeed sterile and do not behaviorally or ecologically disrupt the fitness of natural or wild stocks.

3.7.2 Adults Mated

A. Prevent founder effects by ensuring that hatchery founders represent a statistically significant sample of the donor stock's gene pool. In every breeding season, maintain the largest effective population size possible under the operating constraints of a particular hatchery.

These recommendations will serve to reduce losses of genetic variation in hatchery stocks. Effective population size of a hatchery broodstock is usually smaller than the actual number of parents mated. Degradation of genetic variation due to reduced effective population size continues and accumulates over consecutive generations.

To maximize effective population size, hatchery operators must:

1. **breed as many parents as is feasible;**
2. **mate at least one male per female in daily matings;**
3. **whenever possible, split gametes of the least numerous sex into subsets and cross each subset with gametes from a different individual of the more numerous sex; and**
4. **minimize variation in family size at the time of mating**

Recommendation 3 obviously places additional demands on labor and other operational constraints of a particular hatchery. Before implementing this mating procedure in a particular case, it may be desirable to evaluate its operational costs and genetic benefit. Genetic benefit, in terms of increased effective population size should be estimated using equations for effective population size as a function of sex ratio (Falconer 1981, Lande and Barrowclough 1987). Although variance in progeny number is a very important variable that should also be incorporated in this effective population size estimates (Lande and Barrowclough 1987), the necessary data are currently unavailable for most hatchery programs. This omission will not be corrected until families in hatchery stocks are identified, as discussed below.

Variation in family size can be the most important cause of reduced effective population size and, thus, of erosion of genetic variation (Falconer 1981). Family size is the number of progeny, for one female or one male parent, that survive until they reproduce themselves. Minimizing family size variation in a hatchery stock requires mating similar numbers of males and females from each family occurring in the entire group of returning adults. This necessitates unique identification of each family released from the hatchery so that surviving family members can be recognized and counted when they return as spawning adults. One approach would be to conduct incubation and early rearing in separate compartments until fish are large enough to receive long-lasting tags (e.g., PIT tags), and then to estimate family size by reading the tags of adults returning to the hatchery. Future advances in application of DNA fingerprinting methods to fish may eventually allow non-lethal identification of families in the form of an intrinsic, biological tag.

B. Avoid intentional and unintentional artificial selection in collection of parents from donor stock and from adults returning to the hatchery.

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Hatchery broodstock should represent similar proportions of all life history traits existing in wild or natural stocks with which their progeny may genetically interact.

Some agencies promote periodic infusion of gametes from wild or natural stocks into hatchery stocks with the expectation that this will keep genetic resources and life history patterns of hatchery stocks similar to those of wild and natural stocks with which they genetically interact. *This strategy, however, will be futile if variation in family size is not minimized.* To a lesser extent, effectiveness of the strategy also will be reduced if other recommendations for maximizing effective population size, preventing founder effects, and avoiding artificial selection in the hatchery are ignored. Carefully designed monitoring of genetic resources and life history patterns in hatchery and interacting stocks is therefore needed to assess effectiveness of periodic infusions of gametes from wild or natural stocks.

3.7.3 Fertilization Protocol

A. Maintain high effective population size and low variation in family size by using the milt from an individual male to fertilize the eggs of an individual female (Withler 1988).

B. In cases where effective population size can be increased by breeding more than one male per female, use the milt of a different individual male to fertilize each separate subset of eggs from an individual female.

C. In situations where egg supply is severely limited or male fertility is highly variable, pool the milt from overlapping pairs of males (A and B, B and C, C and D, etc.) and immediately fertilize eggs of individual females (Gharrett and Shirley 1985).

These recommendations differ from the common practice of pooling milt from several or more males prior to fertilizing a lot of eggs from an equivalent number of females. Pooled milt, however, leads to unequal contribution of gametes from different males due to differences in potency of their milt (Withler 1988). Consequently, effective population size is reduced due to unequal sex ratios, increased variation in family size, and smaller total number of parents.

3.7.4 Rearing Practices

A. Reduce artificial selection and hatchery-induced family size variation during incubation, rearing, and in fish releases.

Maintain uniform rearing conditions for all fish of the same stock. Avoid non-random culling of progeny during incubation, rearing, and in fish released. Evaluate the use of volitional releases as a means of reducing inadvertent selection.

B. If artificial selection programs are planned or practiced, evaluate if they are consistent with genetic conservation goals.

Require small-scale experimentation prior to full adoption of an intentional selection program. Require: well-defined goals; assessment of changes in genetically correlated traits; monitoring for progress towards stated goals; and monitoring for impacts on genetic resources and life history patterns of wild and natural stocks with which the selected stock may genetically interact.

C. Consider quantitative assessment of the potential that hatchery environments inadvertently select against life history traits important for fitness of hatchery-reared fish in natural environments.

A scientifically sound research and monitoring program would be needed to assess the circumstances under which this concern is valid. Examples of hatchery environmental conditions to examine are incubation and rearing temperatures, rearing densities, and timing and site of releases.

3.7.5 Size of Donor Stock Remaining to Reproduce Naturally

A. Ensure that numbers of individuals remaining to reproduce naturally are sufficiently large to prevent avoidable losses of genetic variation in the donor stock.

B. Prevent selective removal of adults to ensure existing life history patterns of the donor stock are conserved in individuals remaining to reproduce naturally.

For most wild and natural stocks, this recommendation is secondary to those regarding handling of hatchery stocks that may interact with them. This recommendation complements advice regarding effective population size and artificial selection of hatchery stocks. As in hatchery stocks, maintenance of genetic resources and life history patterns in the naturally reproducing component of donor stocks is influenced by effective population size. If agencies establish a lower limit on numbers of individuals remaining to spawn naturally, they must recognize that different lower limits may be necessary for different stocks. Attributes of the natural stock to consider include its population dynamics, viability in the face of fishing mortality and degraded natural habitats, and historically natural levels of genetic variation. Also as in hatchery stocks, prevention of intense artificial selection on the naturally reproducing component of the donor stock guards against loss of genetic variation needed for evolution and perpetuation in natural environments.

Threatened and endangered stocks, which have experienced severe declines in abundance due to cumulative human impacts, present particularly difficult cases. When stock rehabilitation relies primarily on hatchery production as a means of rapidly increasing abundance, natural reproduction is further reduced by removal of gametes from many or all adults. When rehabilitation relies primarily on improving conditions for successful natural reproduction, use of hatchery production may be precluded. Genetic conservation implications of these alternatives and ways to strike a balance between them must be carefully considered. Agencies must rely on best available scientific information, but recognize that decision making will inevitably involve educated value judgements.

4. INDIRECT GENETIC IMPACTS OF HATCHERY FISH

Frequent releases of large numbers of hatchery fish may have indirect genetic effects on wild and natural stocks. They may swamp mixed-stock fisheries, leading to reproductive overfishing of less productive wild and natural stocks. Genetic consequences of reproductive overfishing are reviewed in Kapuscinski and Jacobson (1987) and are beyond the scope of this report. Ecological interactions, such as competition for spawning sites and other limiting resources in natural habitats, also may indirectly change genetic resources and life history patterns of wild and natural stocks (Vincent 1987, Skaala et al. 1990).

4.1 Agency Policies on Indirect Genetic Impacts

Documents of IDFG, ODFW, WDW, and a FWS draft have clauses related to indirect genetic impacts of hatchery fish whereas WDF and approved FWS documents do not.

4.2 Policy in FWS Documents

The draft FWS-3 indirectly refers to this issue by prohibiting fish stocking where it "will threaten the persistence or reduce the productivity (recruits per spawners) of viable populations of the same or different species." Criteria for evaluating this threat should be developed. FWS-6, which guides activities only at the Warm Springs National Fish Hatchery, prohibits escapement of fin-clipped hatchery fish above the hatchery location. Also, FWS-7 is a Region 1 "policy on stocking fish at other than designated sites." It addresses emergencies when fish held in a distribution truck cannot be released at their designated site. While the intent of this policy may be interpreted to be protection of genetic resources of naturally-reproducing stocks, explicit statements to that effect are missing for "designated" and "alternate" sites.

4.3 Policy in IDFG Documents

Partly in recognition of indirect genetic effects, no new hatchery programs were implemented during 1985-1990 (IDFG-1, p. 21). Major expansions of hatchery production are planned for the near future "as mitigation for losses to Idaho runs attributed to lower Snake River hydroelectric dams (IDFG-4)." The 1990-1995 Anadromous Fisheries Plan, currently in a draft not ready for public review (Steve Yundt, IDFG, personal communication), may have guidelines to prevent indirect genetic impacts of these expansions.

4.4 Policy in ODFW Documents

ODFW-1 limits "the number of all naturally spawning hatchery fish to no more than 50% of the total number of naturally spawning hatchery and wild fish." The use of a constant percentage value is inconsistent with the goal of genetic conservation. A different limit on hatchery fish may be advisable in different cases. The appropriate number will depend on the purpose of the hatchery program (e.g., stock rehabilitation versus stock enhancement), the population dynamics of the naturally spawning stocks, and the carrying capacity of the habitat.

4.5 Policy in WDW Documents

The policy in WDW-1 is to minimize "competitive impacts of hatchery fish on wild stocks" either by "selecting a hatchery stock with earlier return and spawning timing than the wild stock" or "keeping smolt numbers at a level that will not result in a large escapement of hatchery fish." WDW-2 and WDW-3 do not address ecological interactions of hatchery fish with wild fish but do refer to problems associated with mixed-stock fisheries.

4.6 Improvement of Policies on Indirect Genetic Impacts

A. Institute policies and guidelines on indirect genetic impacts of hatchery stocks on wild and natural stocks.

Owing to the magnitude and frequency of fish releases from hatcheries, the pervasive degradation of natural habitats, and the susceptibility of salmonid populations to density-dependent effects (e.g., McCarl and Rettig 1983, Vincent 1987), the potential for indirect genetic impacts on wild and natural stocks may be substantial. Genetic conservation is threatened if policies ignore this potential and focus only on direct genetic impacts of interbreeding between hatchery and wild or natural stocks. Effective hatchery policies and guidelines therefore must address this concern.

B. Develop guidelines for case-by-case determination of allowable numbers of hatchery fish released in order to minimize indirect genetic impacts.

Appropriate numbers of hatchery fish to release depend primarily on the population dynamics of the wild and natural stocks in the recipient environment and the carrying capacity of the habitat.

5. GENETICS RESEARCH AND MONITORING

Research and monitoring needs for salmon and steelhead hatchery programs fall into three major categories. First, better understanding is needed of the status and variability of genetic resources in wild and natural stocks and their importance for ensuring perpetuation of stocks and species. Second, hatchery programs need to be properly designed and evaluated for their effectiveness in sustaining genetic resources of hatchery stocks. Third, monitoring of wild or natural stocks with which

hatchery stocks may interact is needed to ensure conservation of their genetic resources and life history patterns.

5.1 Research and Monitoring Needs in Agency Documents

FWS, ODFW, and WDF documents refer to research or monitoring related to genetic concerns of hatchery programs. Other agency documents are silent on this topic.

5.2 Research and Monitoring in FWS Documents

FWS-1 calls for cataloging "characteristics and management information for each available fish strain in the system." FWS-2 refers in several places to research or information on "genetic traits" and mandates assessment of hatchery fish performance and their impacts on "the genetic integrity and viability of wild stocks involved and the implications for meeting management objectives." Neither document specifies the types of genetic characteristics to emphasize.

Prior to any stock transplantations, the draft FWS-3 requires collection of information to allow determination of threats to persistence and productivity of "viable native populations." Types of information needed are not specified. FWS-3 also calls for improved knowledge about inbreeding, outbreeding and genetic consequences of harvest and habitat loss or degradation.

5.3 Research and Monitoring in ODFW Documents

The Wild Fish Management Policy in ODFW-1 mandates a program to monitor the genetic status of representative populations, but does not provide relevant guiding principles or criteria.

5.4 Research and Monitoring in WDF Documents

WDF-1 calls for several types of monitoring regarding hatchery programs. These include monitoring of:

1. achievement of goals and effects of intentional artificial selection, if it is undertaken;

2. biological characteristics of adults returning to the hatchery;
3. location, size, identity, and performance of naturally spawning stocks in close proximity to hatcheries;
4. efforts to keep different intraspecific stocks reproductively separated in hatcheries; and
5. incidence of accidentally produced interspecific hybrids.

5.5 Improvement of Genetics Research and Monitoring

Conservation of salmon and steelhead genetic resources depends heavily on proper understanding of natural evolutionary processes and impacts of hatchery programs on these processes Such understanding will only come from well designed research and monitoring as outlined below. A particular recommendation may contain both research and monitoring components. Details about research and monitoring methods are beyond the scope of this report. The topic of appropriate methods is introduced by Riggs (1990, Appendix VI) and Lande and Barrowclough (1987, pages 114-119).

A. Develop evolutionarily valid criteria for assigning wild or natural stock status to naturally reproducing fish populations.

Factors to consider include history of stock transplantations, natural demographic history of the population, generations of interbreeding with hatchery stocks, magnitude of interbreeding with hatchery stocks, and genetic tag data (e.g., from DNA analysis). Uncertainty about these factors must also be considered in a biologically rational manner.

B. Monitor levels of genetic variation for life history traits in hatchery stocks.

Standard methods of quantitative genetic analysis are especially appropriate because they assess polygenic variation for quantitative traits. Such polygenic variation is most important for adaptive evolution of managed populations in natural environments (section 12.1.B). Determination of single gene variation, as done by analysis of protein polymorphisms or DNA, is of secondary importance for ensuring long-term perpetuation of fish stocks in natural environments but is a useful and complementary tool for addressing certain questions.

Monitoring programs must be designed to evaluate and prevent two sources of loss of genetic variation in hatchery stocks. First, random losses of genetic variation must be evaluated by monitoring effective population size in every breeding season, particularly as affected by variation in family size. Second, systematic losses of genetic variation must be considered by monitoring sources of inadvertent artificial selection.

C. Monitor genetic resources and life history patterns of wild or natural stocks with which hatchery stocks may genetically interact.

Similarities and differences between well-performing naturally reproducing stocks and hatchery stocks must be addressed. As explained for recommendation 5.5.B, monitoring needs to focus primarily on polygenic variation, and secondarily on single gene variation. Additionally, some relevant demographic information is obtainable from fisheries and stream surveys.

D. Determine susceptibility of naturally reproducing stocks to indirect genetic impacts due to ecological interactions with hatchery stocks.

Factors to consider are introduced in section 4.6.B.

E. If intentional selection programs are used, undertake carefully monitored small-scale experiments before considering operational implementation.

Requirements for any undertaken selection program are outlined in section 3.7.4.B.

F. Develop a database of life history patterns, genetic variation, and population dynamics of naturally reproducing and hatchery stocks.

Ideally, the database would integrate temporal and spatial information from the entire Columbia River Basin for genetically or ecologically interacting stocks. Such a database will facilitate research and monitoring of genetic concerns influencing sustainability of salmon and steelhead

stocks. It will also improve decision making about management actions in light of genetic conservation goals. For example, it could provide valuable information for making decisions about:

1. initiation of new hatchery programs;
2. improvement of new hatchery programs;
3. selection of suitable donor stocks;
4. size of donor stock remaining to reproduce naturally;
5. interbreeding between hatchery and naturally reproducing stocks; and
6. intentional selection programs.

APPENDIX I. AGENCY DOCUMENTS ANALYZED

Agency abbreviations used in the text are given in parentheses.

U.S. Fish and Wildlife Service (FWS)

FWS-1. Statement of Policy Regarding Fish Broodstock (2/12/88)
FWS-2. Implementation Guidelines for the National Broodstock Program (9/14/88)
FWS-3. Draft Fish Gene Resource Protection Policy [12/90 from R. Reisenbichler]
FWS -4. Anadromous Fish Management - brief policy statement for Region 1, signed 2/9/79 by Regional Director [obtained from T. Sheldrake]
FWS-5. Region 1 Broodstock Spawning, Egg Incubation, and Egg Handling Guidelines - memorandum from Assistant Regional Director, signed 9/18/89 [obtained from T. Sheldrake]
FWS-6. Warm Springs National Fish Hatchery Operation Plan 1988-1991 [obtained from T. Sheldrake]
FWS-7. Policy on Stocking Fish at Other than Designated Sites, signed 2/12/85 by Associate Director of Fishery Resources [obtained from T. Sheldrake]

Idaho Department of Fish and Game (IDFG)

IDFG-1. Idaho Anadromous Fisheries Management Plan 1985-1990 (March, 1985)
IDFG-2. Transfer Plan (part of Howell et al., 1985)
IDFG-3. A Vision for Idaho's Future: Department of Fish and Game Policy Plan 1990-2005, **Public Review Draft** (May, 1990)
IDFG-4. Draft Fisheries Management Plan 1990-1995 (August, 1990)

Oregon Department of Fish and Wildlife (ODFW)

ODFW-1. Natural Production and Wild Fish Management Rules (January, 1990)

Washington Department of Fisheries (WDF)

WDF-1. Hershberger, W. K. and R. N. Iwamoto. 1981. Genetics Manual and Guidelines for the Pacific Salmon Hatcheries of Washington
WDF-2. Seidel, P. 1983. Spawning Guidelines for Washington Department of Fisheries Hatcheries
WDF-3. Salmon Stock Transfers Lists (part of Howell et al., 1985)

Washington Department of Wildlife (WDW) - all documents dated 12/12/88

WDW-1. POL-5101 Hatchery Releases to Produce Harvestable Steelhead
WDW-2. POL-5102 Hatchery Releases to Increase Wild Spawning Escapements
WDW-3. POL-5103 Hatchery Releases to Utilize Unused or Underseeded Rearing Habitat
WDW-4. POL-5104 Steelhead Marking, Tagging and Branding
WDW-5. POL-5105 Steelhead Enhancement Coordination
WDW-6. POL-5106 Disposition of Excess Steelhead Juveniles and Eggs

APPENDIX II. AGENCY DEFINITIONS OF STOCK CATEGORIES

Italics : highlight key features of a definition, some of which differ among agencies.
[ ]: explanatory notes that are not part of the agency definition.

HATCHERY STOCKS

FWS-2
Domestic Broodstock - population of fish (*held and fed in a hatchery for more than two generations*) that provides gametes for hatchery rearing programs.

IDFG-1
Hatchery Fish - fish produced in hatcheries or other artificial facilities such as hatching and rearing channels or hatching boxes. [*Criterion for parental history not stated.*]

ODFW-1
Hatchery Fish - a fish spawned and/or reared under artificial conditions *regardless of the history of the parent stock.*

WILD STOCKS

FWS-2
Wild Broodstock - population of fish in the wild that provide gametes for hatchery rearing programs (*includes those populations established by stocking*, anadromous stocks, *and fish held and fed in the hatchery for less than two generations*).

IDFG-1
Wild Fish - a stock of fish, maintaining a population through natural production *with no hatchery supplementation* [*in any past generations*, Steve Yundt, personal communication], often the indigenous stock. ["Indigenous" is not defined.]

ODFW-1
Indigenous - descended from a population that was *present in the same geographical area prior to the year 1800.*
Wild Fish - any naturally spawned fish belonging to an indigenous population of the following species...[list includes all Oncorhynchus sp. found in Oregon.]

NATURAL STOCKS

IDFG-1
Natural Fish - progeny of *hatchery fish* which have reproduced in natural environments.

Natural Production - fish produced by spawning and rearing in natural habitats with no artificial supplementation, *regardless of the parentage of the spawners.*

ODFW-1
Naturally Spawned - spawned in the natural environment without the aid of humans. [*Regardless of parental origin*; Mark Chilcote, personal communication.]

Native - a fish, species, or stock that naturally propagates in a defined geographic area. [*Regardless of parental origin*; this term wasn't used in the administrative rules reviewed but appears in other administrative rules; Mark Chilcote, personal communication.]

Natural Production - the maintenance of naturally spawned fishes and their capacity to reproduce and rear in habitats which allow those fishes to fulfill all their necessary life history functions.

Transplanted Stocks

ODFW-1
Foreign (Imported) - a fish or stock which originated in another stream system, geographic area, state, or country.

Introduced - originating in a stream system, geographic area, state, or country other than where now occurring.

APPENDIX III. UNDEFINED KEY TERMS IN AGENCY DOCUMENTS

Term	Agency Document Location[1]				
Genetic Terms	**FWS**	**IDFG**	**ODFW**	**WDF**	**WDW**
gene resources	FWS-3				
genetic changes	FWS-3				
genetic characteristics		IDFG-1			
genetic dilution		IDFG-1			
genetic diversity	FWS-4			WDF-2	
genetic impacts					WDW-1
genetic (gen.) integrity	FWS-1	IDFG-1,3		WDF-2	
genetic makeup		IDFG-2	ODFW-1		
genetic status			ODFW-1		
genetic traits	FWS-2				
genetically similar[2]			ODFW-1		
optimize gen. integrity	FWS-1				
preserve gen. integrity	FWS-1	IDFG-1		WDF-2	
stock fitness			ODFW-1		
Stock Terms					
indigenous stock		IDFG-1,2			WDW-2,3
locally adapted popul.	FWS-3				
native populations	FWS-3				
natural spawning/reared					WDW-2,3
wild fish	FWS-5				WDW-1-3
Other Terms					
biological requirements	FWS-1				
characteristics (of strains)	FWS-1				
highest quality eggs/fry	FWS-2				
serious depletion (of sp.)			ODFW-1		
quality of natural product.		IDFG-1			

1. Abbreviations for agency documents are given in Appendix I.

2. Definition and criteria for assessment of this term are in preparation (Mark Chilcote, ODFW, personal communication).

APPENDIX IV. GLOSSARY

Terms are defined as they are used in this report. They do not necessarily concur with definitions stated or intended in the agency documents reviewed. Thus, they don't necessarily apply to terms quoted or paraphrased from agency documents. Footnotes indicate sources of borrowed definitions.

allele - an alternative form of the same gene.[1]

effective population size - the number of reproducing individuals in an ideal population that would lose genetic variation due to genetic drift and inbreeding at the same rate as the number of reproducing adults in the real population under consideration.[2]

family size - the number of progeny, for one female or one male parent, that survive to reproduce themselves.

fitness - a measure of reproductive success of an individual that is influenced both by survival and fertility;[1] the frequency distribution of reproductive success for a population of sexually mature adults.[2]

gene - the basic chemical unit of hereditary information that is passed from parent to offspring.[1] Three classes of genes include: structural genes, regulatory genes, and genes coding for molecules (transfer RNA or ribosomal RNA) involved in protein synthesis.

genetic correlation - correlation between the phenotypic values for two traits (e.g., growth rate and age at maturity) due to genes that affect both traits.[2]

genetic diversity - all of the genetic variation within a species. Genetic diversity includes both genetic differences between breeding individuals in a population (within stocks) and genetic differences between breeding populations (between stocks).[1]

genetic drift - random changes in allelic frequencies due to natural sampling errors that occur in each generation; the rate of genetic drift increases as effective population size decreases.[2]

genetic resources - see definition for genetic diversity.

genetic variation - all the variation due to different alleles and genes in an individual, population, or species; includes variation in alleles and genes influencing qualitative traits (under single gene control) and quantitative traits (under polygenic control).[2]

genotype - the set of alleles for one or more genes in an organism; the entire set of genes carried by an individual.[2]

hatchery stock - a group of interbreeding fish that are artificially propagated in a hatchery setting and for whom the breeding history of ancestors may or may not be known.

inbreeding - the mating of related individuals.[1]

natural stock - a group of interbreeding fish that reproduce without the aid of humans and whose ancestors probably include hatchery propagated fish (degree of hatchery fish contribution is known or unknown).

regulatory gene - a gene whose function is to control the transcription of other genes. Regulatory genes themselves do not code for synthesis of a specific protein. (See definition for structural gene.)

structural gene - a gene that codes for formation of a specific protein.

wild stock - fish that have maintained successful natural reproduction and are known to have had little or no supplementation from hatcheries in past generations.[1]

[1]Same or modified definition from Riggs (1990), citing working glossary, prepared for the Northwest Power Planning Council by Fred Allendorf with reference to glossaries appearing in the Council's Fish and Wildlife Program and in Kapuscinski and Jacobson (1987).

[2] Same or modified definition from Kapuscinski and Jacobson (1987).

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Statement of Trout Unlimited

before the

U.S. House of Representatives Committee on Merchant Marine and Fisheries

Subcommittee on Environment and Natural Resources

on the Role of Hatcheries in Recovery of Naturally-Spawning Salmon Populations

Prepared by

Steven N. Moyer, Director of Government Affairs

March 9, 1993

Trout Unlimited (TU) is pleased to provide the following testimony for the Subcommittee's March 9, 1993 hearing on habitat/watershed management and the role of hatcheries in the recovery of naturally-spawning salmon populations of the Pacific northwest region. TU is a national coldwater fisheries conservation organization of over 70,000 members in 435 chapters around the nation. Dedicated to the preservation, protection, enhancement, and restoration of trout and salmon resources, TU is vitally concerned about the fate of declining Pacific salmon stocks. Recovery of these magnificent resources is one of TU's highest priorities.

This hearing, others like it, and the Administration's upcoming "Forest Summit" are essential responses to the worsening ecological crisis in the Pacific northwest region. The plight of the northern spotted owl finally got attention focused on years of mismanagement of forests in the region. Unfortunately, forests were not the only resource mismanaged for decades in the region, and 1991 and 1992 saw three Pacific salmon stocks listed as either threatened or endangered (two Snake River chinook

stocks as threatened in 1992; Snake River sockeye listed as endangered in 1991), due in large part to construction and operation of the Columbia River hydroelectric system. Willa Nehlsen's (et al 1991)[1] landmark study, "Pacific Salmon at the Crossroads: Stocks at risk from California, Oregon, Idaho, and Washington," raised the stakes even higher in this crisis by identifying 214 "at risk" (in immediate need of protection because of low or declining population size) stocks of trout and salmon in those states. The authors of this study also identified 106 Pacific salmon stocks that had already been driven to extinction.

The new, stark reality for the region is that major changes must be made very soon to the land and water development activities that brought our salmon stocks to their knees. If such changes do not occur soon, the Endangered Species Act and court orders will dictate terms to the region for years to come. Pacific salmon <u>are</u> at a crossroads. The time for talk and study of the situation is rapidly dwindling. The time for bold actions, be they administrative or legislative, is now.

Two topics critical to protecting and recovering Pacific salmon are those discussed today, habitat/watershed management and hatcheries. Our comments on these issues are set out below. The other critical components of the crisis are operation of the Columbia River hydroelectric system and harvest of Pacific salmon, by U.S. and Canadian harvesters. TU urges this Committee to look carefully at these other issues also, because resolving them will be crucial to ensuring recovery of these stocks.

The Role of Hatcheries

For too long, hatchery production of Pacific salmon has been the option of choice and the path of least resistance for reconciling the hard choices between extraction of some of the region's

natural resources and conservation of salmon. The outcome of this choice is now overwhelmingly clear: salmon, and the many people dependent on them, have lost. Nowhere is this clearer than the Columbia River system where pre-European settlement runs, estimated at 16 million fish, have been reduced to several hundred thousand wild fish. This dismal record follows after construction and operation of 89 state, federal, and tribal hatcheries, and over one billion dollars spent under the provisions of the Northwest Power Planning and Conservation Act for salmon restoration, much of it on hatcheries intended to mitigate the effects of the Columbia's hydroelectric system.

Hatcheries in exchange for habitat destruction has been a terrible deal for Pacific salmon. The region must immediately and dramatically make substantial changes to improve habitat protection and watershed management (such as those highlighted in Dr. White's statement), provide flows in the Columbia River hydrosystem which nurture and restore wild salmon, and substantially reduce salmon harvest. Importantly, the region must also reform hatchery production of salmon to ensure: 1) cost-effective results; and 2) most critically, that wild stocks are not damaged by hatchery-produced fish.

TU believes that protecting and restoring wild salmon stocks are the keys to all salmon conservation efforts and the acid tests against which all hatchery efforts must be measured. Hatchery production of salmon must, in the words of a now widely used axiom, "first, do no harm," to wild fish stocks. The rich salmon genetic diversity of the region is one of its biological crown jewels. Those jewels have been diminished and tarnished greatly. Salmon conservation efforts should emphasize restoring this diversity and resiliency, not reproducing it in hatcheries where overwhelming evidence suggests we are doomed to fail.

This is not to say that all hatcheries in the region are bad.

Some of the region's hatcheries have contributed substantially to sport and commercial harvest of Pacific salmon. Also, restoration of critically-low stocks of salmon will be dependent on hatchery fish for long term restoration efforts. However, data derived from hatchery operations in the region show that some are not cost-effective and risk damaging wild stock genetic diversity by comingling of wild and hatchery-reared fish of the same stock, and in some cases actually have damaged wild stocks. Just as development activities in the region must be reassessed and modified to better protect wild salmon, so too must the region's hatcheries.

Fisheries managers must place greater emphasis on nurturing wild stocks and must eliminate hatchery and stocking practices which undercut that emphasis.

In recent years, some fisheries scientists have raised serious questions about the effects of hatchery-produced fish on wild stocks. In particular, the widely practiced method called "supplementation," stocking hatchery-reared individuals of a particular stock on top of wild stocks has been questioned because of data showing genetic damage to wild stocks. A study by Nickelson et. al. (1986)[3] demonstrated that stocking of hatchery salmon caused a decline in total fish production by 50% and that this effect lasted into the following two generations. A modeling study by Byrne et. al. (1992)[3] predicted that long-term stocking of fry or smolts led to extinction of native fish in some scenarios. Finally, Waples's review of this issue (1990)[4] led him to conclude that hatchery fish can have substantial direct and indirect genetic impacts on wild fish.

Although it is impossible to quantify, clearly at least some genetic damage is being inflicted on wild Pacific salmon stocks, and others are at risk of being damaged. To alleviate damage and minimize risk, federal, state, and tribal fisheries managers must

conduct thorough genetic monitoring of all stocking operations. To our knowledge, this is not being done on a systematic basis by many of the agencies involved in stocking programs.

Fisheries managers must evaluate and monitor hatchery success to determine cost-effectiveness based on contribution to actual stock abundance.

A second key question for the region's hatcheries is the question of cost-effectiveness. At a time when the fisheries budgets of all agencies are wanting, each dollar spent on salmon recovery must be well justified in terms of contributing to stock recovery. According to Oregon Trout[5], the Oregon Department of Fish and Wildlife recently calculated the cost per adult product from each hatchery in the state. Two examples of cost per adult that are exorbitant are spring chinook from Lookingglass Hatchery at $872 per adult and spring chinook from Irrigon Hatchery at about $10,000 per adult. Clearly, this money would have been better spent on other management procedures, such as habitat restoration. Further, to look again at the Columbia River on a large scale, a 1992 General Accounting Office study found the cost of producing hatchery-reared salmon in the Columbia River basin to be $537,000,000. In light of the Columbia's declining runs and newly listed threatened and endangered stocks, this is a very poor investment.

Even though the Oregon study may have been bad news for some, at least the study was conducted. Again, to our knowledge, few hatchery-operating agencies are conducting cost-benefit analyses that are based on cost per adult, i.e. contribution to the adult stock abundance. To upgrade efficiency of these operations, periodic cost-benefit analyses must be done for each state, federal, and tribal hatchery in the region.

To reduce genetic risk and to ensure cost-effectiveness, an

Environmental Impact Statement (EIS) should be completed for the region's hatcheries.

TU believes that the best way to evaluate the true environmental costs and cost-effectiveness of the region's state, federal, and tribal hatcheries is to follow EIS procedures of the National Environmental Policy Act (NEPA) , or something analagous to an EIS, to assess these operations. Such a process would ensure a common understanding of the best available data on these critical questions, consider a range of alternatives to the status quo based on the best available data, and then lead to modifications to hatchery operations to minimize risk and improve cost-effectiveness. TU recently has taken the initial steps of legal action in California to compel the state fisheries agency to do just this (comply with the state NEPA law) for its state hatchery operation.

Another major benefit of the EIS process would be substantial public involvement in overseeing management decisions involving hatcheries. TU strongly believes that sport and commercial fishermen and the public need to be made aware of the costs and risks associated with hatchery operation, and should have full opportunity to "just say no" if they don't believe the costs and risks are worth the high expense of operating and maintaining hatcheries.

To ensure that standardized procedures are followed, we recommend that the Secretary of the Interior, through the Director of the U.S. Fish and Wildlife Service, be charged with conducting such an NEPA/EIS evaluation. This process should be conducted and completed as quickly as possible so as to help guide recovery efforts of federally listed stocks as well as other regional stocks in decline.

Thanks again for the opportunity to provide these recommendations. We look forward to working with this Subcommittee on resolving the Pacific salmon crisis.

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Statement of Trout Unlimited

before the

U.S. House of Representatives
Merchant Marine and Fisheries Committee

Subcommittee on Environment and Natural Resources

at a Hearing on
Watershed Management in the Pacific Northwest

Prepared by
Dr. Ray J. White, Science Advisor

March 9, 1993

My name is Ray J. White. I am an independent stream habitat consultant in Edmonds, Washington, near Seattle. I am retired from Montana State University but remain on its adjunct faculty. My experience in assessing and restoring salmonid habitat covers 35 years, as a biologist in charge of evaluating Wisconsin's stream habitat management, as a visiting scientist in Europe, as a professor at two universities, and in consulting on many streams. I serve on Trout Unlimited's volunteer Board of Scientific Advisors and I provide this statement on behalf of that organization and its 70,000 members nationwide. I also work with other fishery and conservation groups in the Pacific Northwest, and sit on the executive committee of a coalition of 35 organizations working to salvage the dwindling salmon resource. From close professional association with USFS and BLM scientists and managers, I have some understanding of their missions and of problems and opportunities confronting them--and

a great interest in today's subject.

I strongly support the initiatives in the U.S. Forest Service and Bureau of Land Management for better salmonid habitat, and for greater emphasis on watershed integrity. The potential is great for positive change so that our public forests and grasslands can do more to help prevent the demise of the wild Pacific salmon resource--and help it on the road to recovery. In particular, I support the watershed approaches like those embodied in the Pacific Rivers Council's proposal and in earlier efforts to forge ecosystem-wide management systems like the so-called "Gang of Four" report on late successional forest ecosystems.

As a scientist, I can speak to certain attributes of the watershed approach under consideration here today. It is based on science, it is geographically comprehensive, and it distinguishes between protecting present good habitat and restoring abused habitat. It emphasizes that, first and foremost, we should hang onto the good habitat that's left: our healthy watersheds. And it provides the basis for, as a second priority, restoring the various kinds of damaged habitat. I urge you to put it into effect on federal lands in the Northwest.

Why? Because our Pacific salmon are in bad trouble, because past efforts to solve habitat problems have been inadequate, and

because the salmon need major, coordinated help now.

Things people do have driven the resource to its knees. Washington's, Oregon's, Idaho's, and California's wild salmon populations are pitiful, fast-declining remnants of what they once were. In the last two years, fishing has had to be virtually stopped on many stocks. If we keep doing what we've been doing to our lands, forests and waters, there will soon be no economically viable wild salmon fishery.

Please realize that a national treasure is collapsing. It is collapsing because of us--because of what we are doing. We can still turn the situation around if we change some of our actions, but it will have to be soon.

Again and again in our history, we have destroyed the habitat basis of fisheries and thought that hatchery programs (a sort of fish farming) could make up for it. That hasn't worked. It has never worked. For fundamental biological and economic reasons, it cannot work. Only healthy watershed ecosystems can economically produce salmon on a sustained basis.

In the Pacific Northwest are we going to echo past folly? Will we continue to damage our forest and grassland watersheds and lose the fisheries that depend on them?

In our squandering of one major American fishery resource after another, destruction of virgin forests has played a major role. Beginning over 250 years ago, people cleared the East Coast forests. Together with overfishing, river damming, and pollution, this eradicated our Atlantic salmon by about the year 1900. Massive artificial breeding and stocking in the late 1800s failed to save that magnificent fishery, and recent high-tech hatchery programs on somewhat rehabilitated streams have failed to recreate a significant Atlantic salmon fishery.

We took the Midwest's timber, otherwise abused streams and lakes there, and devastated that region's fisheries. The once-thriving Michigan grayling dwindled as logging pushed across that state, and, by 1932, it vanished. The native Great Lakes fish community, much of which spawned in pre-logging streams, largely disappeared by 1945 or 1950. In it's place is a grotesque assortment of exotics--fishes that don't belong and don't function properly there. They don't behave themselves, so to speak. Now we have to put up with them and make the best of it.

The virtual extirpation of beaver, followed by overgrazing, environmentally abusive hard-rock mining practices, excessive logging, and irrigation diversion, radically changed watersheds and streams in the interior West, annihilating many stocks of cutthroat trout, that region's primary native salmonid. Hatchery programs made the situation worse by genetic disruption and by

introducing competitor species.

If we don't act fast and intelligently in the Pacific Northwest, we will soon complete a colossal repetition of those mistakes. Over 100 locally adapted Pacific anadromous salmon and trout stocks are already extinct: over 200 are at risk[1] of extinction. Only a fast-dwindling vestige of the world's once most spectacular salmon resource remains. And, as you know, several Pacific salmon stocks were recently listed as threatened and endangered, and petitions for listing many more stocks are imminent unless massive change is accomplished soon.

Annually stocking millions of hatchery salmon has failed to stem the decline; it also has damaged wild salmon populations and deluded people into ducking the hard decisions[2] [3] [4] [5] [6]. Among the hard decisions society has all too often avoided are to protect intact habitat and to restore abused habitat. If we make better choices now, the remnant wild stocks can begin to rebuild themselves.

An essential choice is to manage our federal lands differently. We have long tended to emphasize timber cutting and livestock grazing. After the Multiple-Use-Sustained-Yield Act of 1959, more effort toward non-commodity and indirect commodity uses of National Forests began. Still, these were too often token sidelines. It's easy to set policy, then work around it.

Where stream habitat work was done in the Pacific Northwest, it was at first often without scientific understanding; agencies sometimes did not realize how little they knew and proceeded on a so called "common sense" basis, doing more harm than good.

But much has been learned through trial, error, and research. USFS and BLM now have excellent knowledge and methods. What's needed is to eliminate traditional administrative obstacles and provide funding, so the agency stream scientists and managers can, in comprehensive, coordinated ways, do the job they know has to be done.

Let's look at some general areas of stream management capability that have improved over the years. In the past, some stream restoration methods that work wonders in Midwestern creeks were applied to steep West Coast streams and did not withstand high flows[7, 8], but now methods that are more durable and more in keeping with the Northwest's natural stream characteristics are used[9, 10, 11], and there is profound understanding of the needs and possibilities for ecological approaches in such work[12].

Also, until about 15 years ago common sense said wood debris jams in Pacific Northwest streams obstruct salmon runs, and major programs were undertaken to remove such material. But as Forest Service research revealed, salmon, having lived for millennia in streams choked with fallen wood, were well adapted to it; they

usually could get over or around the supposed obstacles, and wood debris accumulations (and beaver dams) proved to help produce salmon in many ways[13].

Old-growth forest sheds large logs and other woody debris into streams, tying their beds together, stabilizing them. The downed wood also traps gravel, forming spawning grounds, and provides complex cover and diverse pools, where fish hide, rest and feed[14] [15]. These effects are especially important on steep Northwest streams.

An unfavorable administrative tendency in the USFS and BLM has been toward quick economic yields and technologic fixes rather than toward ecologic health and long term productivity of lands and waters. It has been a ruin-and-rebuild approach, probably self-deceiving from the start, and often less than whole-hearted on the rebuilding end. Rather than managing conservatively for sustained natural functioning of forests and grasslands, on which such resources as salmon runs depend, there has been radical exploitation, giving high short-term profits to a narrow range of users and damaging fundamental land-water-vegetation functions, followed sometimes by so-called "mitigation." Whenever you hear "mitigation" in connection with stream habitat work, an alarm bell should go off in your mind, and you should examine for trouble.

In trying to mitigatively "fix" stream habitat after destructive logging, roading and grazing, public land agencies have gotten into trouble--applying aspirin while continuing to do what causes the underlying cancer. Stream habitat certainly can be restored. In small, gently-flowing creeks of the East, of the Midwest, and of western mountain valleys, it is relatively easy and inexpensive. But on steep, high-force streams of the Pacific Northwest, doing it right requires substantial investment of resources, something which agencies have too seldom seen fit to spend.

This is not to say that stream habitat restoration should not be done in on the Pacific Northwest's streams. There has been huge damage, and our land management agencies and others should spend the funds needed for healing. And the basic approach should be more one of <u>healing</u> than fixing. The self-healing powers of Nature are tremendous. The main thing is to put Nature in position to exert that power.

To enable healing, the first step is to <u>remove the disease</u>. This means halting or reducing the human activities that are causing the damage. Once that is done, the actions of water, soil and vegetation in shaping stream channels often will do much to bring back productivity for salmon. It is a principle of salmonid stream habitat management that the greatest gains are achieved by alleviating human influences on the worst-abused

streams. But keep in mind, this is second in priority to protecting remaining undamaged habitat.

In other situations, putting Nature in position to self-heal salmon habitat means putting jams of huge logs in streams where such "obstructions" were once removed when the channels were used to float logs to market--and where second-growth forest has not had time to grow and topple enough big trees to restore proper channel structure. Hundreds of years may pass before a second-growth forest does this, even if left uncut.

I submit that it will be most rewarding in the long run NOT to road and cut the scarce remaining old-growth forest, but to manage more conservatively our present timber-harvest forests and grazing lands. Thus, needs for costly "mitigation" will be reduced while reaping sustained benefits, such as salmon runs AND timber AND beef AND wildlife AND recreation. Many of the methods for such management have been developed by aquatic ecologists and hydrologists within USFS and BLM. The agencies should be reformed to enable these people to put into practice what they have developed.

Organizing such reforms according to watersheds will be far more effective than according to the present administrative or political boundaries. A watershed is a logical unit in terms of water catchment and flow and of the plant and animal life

deriving therefrom. A watershed is an ecosystem encompassing a nested system of forest (or grassland) and aquatic ecosystems.

There is much call of late for "ecosystem" management. This makes eminent sense--managing for the function of the system, rather than managing parts of it piecemeal, without regard for other parts or the whole system. We do not yet know the forms that ecosystem management will take, but managing for ecological integrity (in a word, health) of watersheds will surely be a good start. The Pacific Rivers Council strategy for hanging onto the last best watersheds in the Pacific Northwest and for securing them by putting people to work stormproofing the human-affected edges of such watersheds would seem to be one helpful first step. It is in keeping with the new management thrusts that are developing within USFS and BLM, based on scientific understanding of interrelationships among land, water and organisms. I urge that in guiding USFS and BLM, Congress consider the proposal and the ideas presented here.

Correcting the abuse of federal lands will go a long way toward ensuring the survival of many of the salmon stocks that are today in great peril. Ultimately, however, we also must address the threats that derive from the abuse of the non-federal lands that lie within our Pacific Northwest watersheds. To do so, Congress will need to take a hard look at the Clean Water Act. One of the Clean Water Act's primary objectives is to

restore and maintain the biological integrity of all waters of the United States. As Congress reauthorizes the Clean Water Act, I ask you to consider strengthening the Act's "non-point source" provisions and creating a strong anti-degradation policy to protect all of our nation's outstanding national resource waters. Doing so will mean that we can achieve on a comprehensive basis the same objectives that are under consideration here today.

Thank you. I would be happy to answer any questions you might have.

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O R E G O N T R O U T

TESTIMONY OF OREGON TROUT, INC.

before

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON
MERCHANT MARINE AND FISHERIES
SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES

MARCH 5, 1993

The Honorable Gerry E. Studds, Chairman

Dear Mr. Chairman:

Oregon Trout, Inc. welcomes your invitation to provide written testimony to the committee regarding the role of hatcheries in recovery of Pacific salmon. We would appreciate this statement being included in the committee record.

Oregon Trout, Inc. is the lead petitioner on four species of Columbia River salmon that were listed under the Endangered Species Act in 1991. Oregon Trout incorporated in 1983 with the mission of conserving and restoring long-term abundance of wild salmon, trout, and steelhead. The organization in headquartered in Portland, Oregon and has several thousand members throughout the Pacific Northwest.

The Committee's inquiry should be expanded.

The Committee's letter of February 19, 1993 asks three questions each of which presumes that some form of artificial production, a very expensive process, is necessary for the survival and restoration of "naturally-spawning" salmon populations. That presumption is not necessarily true and could lead the Committee to erroneous conclusions. We suggest that the Committee ask the threshold questions: "Is any form of artificial production necessary to protect and restore naturally-spawning salmon populations? If so, what are the criteria for use of artificial production and what steps can be taken without artificial production to protect and restore those populations?

With an expanded focus the Committee will learn that in many cases artificial production is neither necessary nor beneficial to naturally-spawning salmon populations..

To Protect and Restore Native Fish and their Ecosystems
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Artificial production has no role until the reasons for decline of naturally-spawning salmon populations are known and analyzed.

Salmon populations can decline for a number of reasons including,

1. Overfishing,
2. Degraded water quality,
3. Lack of sufficient water quantity,
4. Disease,
5. Natural catastrophe -- forest fire, land slide, natural water pollution, etc.,
6. Poor ocean conditions, lack of ocean based feed,
7. Freshwater habitat destruction.

Clearly, artificial production is no substitute for abundant clean water, conservative harvest management, and conservation of freshwater habitat. Survival of all naturally spawning populations requires those components. The use of artificial production is not indicated if decline is caused by curable ecological problems.

Here is an analogy: A doctor does not prescribe oxygen to a patient whose cardio-vascular system is in poor condition due to lack of exercise. The doctor treats the limiting factor -- lack of exercise. A prescription for oxygen simply makes the patient dependent on oxygen and permits the root cause of the problem to go untreated. Fish hatcheries are the like oxygen to the flabby patient. They permit the environmental causes of decline to go untreated while making the resource entirely dependent on an artificial cure, i.e. hatcheries.

Hatcheries are useful only after the root causes of fishery decline are known and treated. Small temporary "jump start" hatcheries may be useful to conserve extremely depleted populations while ecological bottlenecks are removed. Thereafter no artificial production is necessary.

Oregon Trout recently completed a strategy for maintaining the productivity of Pacific salmonids. Our strategy is attached for your consideration. It includes recommendations for hatchery use.

Hatcheries may produce unwanted and expensive long-term problems.

1. **Hatcheries produce dependence.**

Once started, hatcheries do not close. They require endless operation and management expense. Fishery based economies become dependent on continuous hatchery output. In essence, hatcheries become a form of social welfare and subsidy for habitat destruction.

2. **Hatcheries permit continued habitat destruction and water degradation.**

Historically, fish hatcheries have been used as "compensation" for habitat destruction. Once the hatchery compensation is in place little or no incentive exists to cure habitat destruction. Nor is there incentive to prevent further habitat destruction.

3. **Hatcheries are extremely expensive substitutes for stewardship of fish habitat and clean water.**

Hatcheries have capital costs and virtually infinite operation and management costs. Often the cost per returning adult fish is very high, sometimes higher than the retail value of the fish. For example, the Oregon Department of Fish and Wildlife has calculated the cost per adult product from each hatchery in the state. Trask River spring chinook cost $78.00 per adult (this is a coastal hatchery with no dams in the watershed). Lookingglass Hatchery spring chinook cost $872.00 per adult (this is a hatchery above eight federal dams in the Columbia River system). Irrigon Hatchery spring chinook cost $10,000 per adult (this is another Columbia River hatchery above only three dams).

In 1992 the General Accounting Office calculated the costs of hatchery salmon production in the Columbia River from 1981 to 1991 to be $537,000,000. However, during this time natural salmon stocks continued to go extinct and five stocks were listed under the Endangered Species Act. The investment in hatcheries failed to arrest the salmon decline.

On the other hand, natural production is cheap. Fish that reproduce in healthy productive habitat cost nothing. The costs of restoring habitat and purchasing water are one time capital costs. They are by far the better long term investment.

4. **Hatcheries are not reliable.**

There is growing abundant evidence that hatchery enhanced fisheries begin to fail after a period of years. Hatcheries necessarily eliminate a number of natural selection processes that humans cannot duplicate. Impaired operation of natural

selection in any population of animal weakens that population's adaptation to its environment. Year after year of hatchery output eventually weakens stocks subject to "enhancement" or "supplementation". In time those stocks cannot withstand environmental stress and change. Eventually they fail and the stock collapses leaving few alternatives other than importation and permanent artificial production of a new strain.

5. Hatcheries add risk to the viability of naturally spawning populations.

Hatchery fish cause considerable risk to natural populations through genetic interaction. A sixteen year evaluation of hatchery and wild steelhead interactions by the Washington Department of Wildlife shows that hatchery fish survival is ten times lower than wild fish in the natural stream environment. Also, when hatchery and wild salmon interbreed the resulting generation is less fit and survives at a lower rate thn the wild fish.

Dr. Gary Meffe, University of Georgia, called salmon hatcheries on the Pacific coast "techno-arrogance" and summed up the problems in a recent article in Conservation Biology. He says

> There are at least six reasons why the hatchery approach will ultimately fail: (1) data demonstrat that hatcheries are not solving the problem--salmon continue to decline despite decades of hatchery production; (2) hatcheries are costly to run, and divert resources from other efforts, sucha as habitat restoration; (3) hatcheries are not sustainable in the long term, requiring continual input of money and energy; (4) hatcheries are a genetically unsound approach to management that can adversely affect wild populations; (5) hatchery production lead to increased harvest of declining wild populations of salmon; and (6) hatcheries conceal from the public the truth of real salmon decline. I recommend that salmonid management turn from the symptoms to the causes of decline.

It is also well known that disease outbreaks are common in hatcheries. No amount of caution and good intention eliminates that risk. Diseased fish sicken others in the ecosystem causing massive losses. Moreover, loss of entire generations of hatchery stock is not unknown from other causes such as pump failure, water pollution, feed contamination, and vandalism. If the brood stock was taken from naturally spawning populations the progeny of the broodstock is lost forever and the effective population size of the natural stock is permanently lowered. Loss of effective population size narrows genetic variability and vigor.

Conclusion

Inquiry into restoration of Pacific salmonid abundance should not be limited to artificial production. As explained above and in the literature cited below such

restoration depends on a complex web of factors. Over reliance on hatcheries will only compound the existing problem, waste taxpayer money, and further erode public confidence in government.

Respectfully submitted,

Bill M. Bakke
Oregon Trout, Inc.

Attachments

Literature citations list.
Bakke, *Managing for Productivity: A New Strategy for Salmon Recovery* (1993).

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TESTIMONY BY PETER BERGMAN BEFORE THE SUBCOMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES OF THE COMMITTEE ON MERCHANT MARINE AND FISHERIES.

I am aware of the experts who will provide testimony to you and I will not dwell on topics I'm sure they will discuss in detail. Briefly, hatcheries used properly are useful or essential for the recovery of many natural salmon stocks. An extreme example is the use of hatcheries for the several remaining Redfish Lake sockeye in Idaho; retaining these fish in hatcheries initially for their full life cycle appears to be their only hope for survival.

There are enough examples of hatcheries like Spring Creek in the Columbia River or Minter Creek or Green River in Puget Sound to show that hatcheries used for production of cultivated salmon stocks can be very successful. Using hatcheries for rearing salmon to increase natural runs - i.e. fish that spend their entire lives in nature - is less well understood, but in various modes I have little doubt they can play a beneficial role. An important discussion of hatcheries and the protection of natural populations is the recently completed NMFS paper "Pacific Salmon and Artificial Propagation Under the Endangered Species Act".

I would like to focus my testimony on the decision-making process which involves anadromous fish hatcheries in the Pacific Northwest. Making hatcheries successful for any purpose requires a logical management system, and the process used in the past will require major revisions to allow hatcheries to achieve their potential. The following remarks are specifically about the Columbia Basin, because I have recently examined it and because of its regional importance, but the issues are widespread.

A key point to put my comments in perspective is that hatchery production in the Columbia has increased enormously over recent decades but adult production has not increased and has probably decreased. I believe the primary reason for this is an irrational decision-making process.

The first management problem I would like to describe is jurisdictional. The Columbia contains about 100 anadromous fish hatcheries. They are operated or affected by a multitude of jurisdictions--at least three federal agencies, three states, several Indian tribes, several coordinating bodies, and a number of electric utilities. Certainly most of the important management decisions are systemic, involving groups of hatcheries, sub-basins, or the entire basin. But there is no directed authority or accountability for successful management. No one is in charge.

There have been some recent, major efforts to coordinate these hatcheries. However, the system-wide decision making process is fundamentally based on consensus. Opinions on any given issue are ordinarily diverse, due to varying jurisdictional goals and a paucity of scientific information. Thus obtaining consensus is extremely difficult, and if obtained rarely represents significant progress.

The second hatchery management problem is the process by which past experience is transformed into current management decisions. Obviously, in order to improve, proper goals must be established and the results of actions must be measured in terms of effects on the goals. But ordinary practice has been to judge success by numbers or pounds planted from hatcheries rather than the adults or catch produced, which are the proper goals.

Whatever past goals should have been, they will clearly change in some fashion with natural stock emphasis. In any case, there is no modern, organized process to collect and analyze relevant information about measures of success to transform the results into new policies. Further, there is no adequate feedback loop to consider what research is most likely to be productive to improve success. There is, of course, much valuable experience currently in the system which, properly organized, could yield much progress. Most of this remains in the minds of individuals and disappears from the agencies when these persons leave, when it should be stored in modern computers which could provide institutional memories to avoid such losses.

In conclusion, the anadromous hatchery system of the Columbia, and probably the Northwest, requires a central management authority. It should have ultimate responsibility for establishing goals, comprehensive planning, and monitoring and evaluating success in meaningful terms. It must be held accountable, be able to enforce its dictates, and will require a complete set of modern information management tools. This is not a proposal for changing existing agency control of particular hatcheries; rather, a higher level of control is required to remove jurisdictional gridlock and promote progress.

Review of the Oregon Forest Industries Council Report:

"A Review of Management and Environmental Factors Responsible for the Decline and Lack of Recovery of Oregon's Wild Anadromous Salmonids"

(V.W. Kaczynski and J.F. Palmisano, June 1992)

Prepared by the Oregon Department of Fish and Wildlife

Coordinated by
Habitat Conservation Division
Oregon Department of Fish and Wildlife
Portland, Oregon
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EXECUTIVE SUMMARY

In June 1992, the Oregon Forest Industries Council released a report titled *"A Review of Management and Environmental Factors Responsible for the Decline and Lack of Recovery of Oregon's Wild Anadromous Salmonids"*. The purpose of the document was to evaluate and determine the relative contribution of management and environmental factors to the decline and lack of recovery of Oregon's salmonid stocks. The Oregon Department of Fish and Wildlife conducted a review of this report to determine if it provided constructive insight into defining and evaluating the problems affecting Oregon's anadromous salmonid resources.

The Department's review of the report involved two major tasks: (1) a review of the scientific information presented in the report, and (2) an evaluation of the analytical methods used to rank the relative importance of factors implicated in the decline of Oregon's anadromous fisheries resources. The review of the scientific information included verification of the accuracy of the data and conclusions extracted from a portion of the cited scientific studies and information sources, and a review of the completeness of the scientific literature presented in the report. The review of the analytical methods used to rank the factors included an assessment of the technical validity of the methodology, and an evaluation of the scientific basis for the analyses according to the scientific information presented in the report.

The Department's review indicated that the report contained major technical and analytical weaknesses caused by a failure to stratify analyses by location, by species and by life history stages within species. The relative importance of factors affecting the productivity of salmonids in Oregon varies by region and watershed according to the distribution and intensity of various human activities and environmental conditions. The report's analyses of the relative importance of environmental and management factors were based upon a statewide pooling of information that failed to reflect regional variability. In addition, certain changes in habitat or management practices will affect salmonid species differently, and will have varying effects on different life history stages of a given species. The analyses presented in the report fail to account for variability between species and life history stages, and limit the evaluation of the relative importance of the factors to the effects on "salmonids" as one homogenous group.

A review of the scientific information presented in the report identified several problems including: (1) a failure to base analyses or conclusions on information presented in the report, (2) inaccuracies in the statistical information presented in the report, (3) inaccurate interpretation or reporting of scientific studies, (4) failure to analyze data using rigorous and scientifically valid methods, and (5) incomplete summary of scientific information available for a topic. These problems directly affect the validity of the information and conclusions contained within the report.

The Department reviewed the methods used to rank the relative importance of the environmental and management factors, and assessed the validity of the conclusions derived from the analyses. The review indicated that these analyses were not based on empirical data and were largely subjective. The authors presented a matrix as a method to evaluate the relative importance of the factors, but the approach used in the matrix was inadequate. The fundamental problems with the report's matrix analysis methodology were: (1) the analysis was not stratified by location and species, (2) the impact of the factors were arbitrarily ranked, (3) some population impacts were multiple measures of the same effect on salmonid populations, (4) the measure of a

factor's impact was arbitrary and was not based on a change in salmonid population abundance, and (5) the method used could not measure the impact of multiple factors acting simultaneously on a population. These matrix problems resulted in conclusions that were oversimplified, incorrect and not scientifically valid.

To demonstrate the complexity of quantifying and evaluating the effects of various factors on salmonid production in a scientifically valid manner, the Department provides an example of an alternative matrix approach. The example approach is based upon a prediction of the relative change in adult salmonid production due to a variety of factors, and is consistent with concepts currently being used in life cycle modeling to weight the effects of various mortality sources on salmonid production in the Columbia River Basin. A major difference between this approach and the report's matrix is that the relative importance of a factor, or combination of factors, is based upon the predicted change in total adult production of a species.

The Oregon Department of Fish and Wildlife has concluded that this report does not provide an adequate scientific analysis or justification to support the conclusions concerning the relative contribution of environmental and management factors to the decline of Oregon's anadromous salmonids.

BACKGROUND

In June 1992, a report sponsored by the Oregon Forest Industries Council (OFIC) titled *"A Review of Management and Environmental Factors Responsible for the Decline and Lack of Recovery of Oregon's Wild Anadromous Salmonids"* was released to the public. The purpose of this document was to evaluate management and environmental factors to determine the relative contribution of these factors to the decline and lack of recovery of Oregon's native salmonid stocks. This report has been heralded by the OFIC as "...the most comprehensive evaluation done to date on the relative reasons for the crisis in our fisheries."

The Oregon Department of Fish and Wildlife (Department) is very concerned with the decline of anadromous salmonid stocks in the Pacific Northwest. The scope of these declines was discussed in an American Fisheries Society report (Nehlsen et al. 1991). Given the importance of this issue to the activities and responsibilities of this agency, and to the citizens of Oregon, the Department conducted a review of the OFIC report to determine if it provided constructive insight into defining these current problems. This report presents the findings of our review.

INTRODUCTION

The Department's review of the OFIC report involved two major tasks: (1) a review of the scientific information presented in the report, and (2) an evaluation of the analytical methods used to rank the relative importance of factors implicated in the decline of Oregon's anadromous fisheries resources. The review of the scientific information included verification of the accuracy of the data and conclusions extracted from cited scientific studies and information sources, and a review of the completeness of the scientific literature presented in the report. The review of the analytical methods used

to rank the factors included an assessment of the technical validity of the methodology, and an evaluation of the scientific basis for the analyses according to the scientific information presented in the report.

SCOPE OF THE INFORMATION AND ANALYSIS

The Department's review indicates the OFIC report contains major technical and analytical weaknesses. These weaknesses are based upon failures to stratify analyses by location and by species.

Failure to Stratify by Species and Location

The relative importance of factors affecting the productivity of salmonids in Oregon varies by region, and watershed according to the distribution and intensity of various human activities and environmental conditions. The OFIC report's analyses of the relative importance of various environmental and management factors (Tables R-1, R-2, Table 2.3-1) are based upon a statewide pooling of information that fails to include regional variability in assessing the importance of these factors.

The report's primary source of information comes from the Columbia River basin. Conclusions from this information are generalized to the entire state. Specifically, the majority of information presented on fishery harvest and management, hydroelectric development impacts, and predation is based upon Columbia River data. Reliance upon the history and dynamics of anadromous stock declines in this area to make conclusions for all populations within the State is unwarranted because of the following:

(1) hydroelectric development, land and water use in this basin is unequalled in any other basin of the State;

(2) the Columbia River basin has historically been the most active area for commercial fisheries, experiencing harvest rates well in excess of most other Oregon watersheds;

(3) predation results are uniquely applicable to large hydroelectric reservoirs of the Columbia River Basin;

(4) the majority of wild anadromous salmonid production occurs in coastal tributaries totally unrelated to Columbia River conditions.

An example of how the use of Columbia River information fails to depict statewide conditions is the authors use of Columbia River tule and coho harvest data to represent the impacts of harvest on all wild populations of anadromous salmonids (V.W. Kaczynski and J.F. Palmisano, June 30, 1992). These stocks are of hatchery origin and are managed for high catch rates. Harvest rates predicated on these hatchery stocks is not a valid measure of the relative statewide harvest impacts on coastal stocks of coho and chinook, or on stocks of steelhead or searun cutthroat trout.

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Failure to Stratify by Species and Environmental Affects

Certain changes in habitat or management practices will affect salmonid species differently. In addition, these changes will have varying effects on different life history stages of a given species. Yet, the analysis presented in the OFIC document regarding the relative importance of environmental and management factors is limited to the effects on "salmonids" as one homogenous group.

This lack of differentiation between species or life stages among salmonids is apparent in the assessment of environmental and management impacts. The report provides no analysis that recognizes differential responses by different species that use similar or different environments in unique ways. For example, an alteration of freshwater habitat that reduces the abundance and quality of pools may not significantly affect the survival of steelhead fry, but will significantly reduce the survival of juvenile coho and age-1+ and older steelhead and cutthroat trout. The problem is further enhanced when the relative importance of these factors are represented as a statewide assessment of such different species as coastal stocks of coho and chinook, or on stocks of steelhead or searun cutthroat trout that may use the same habitat at different times. The report should provide an analysis for each species and each location or watershed, weighted according to the percentage of that species to the entire anadromous population, for the analysis to adequately depict the relative importance of factors on a statewide basis. The failure of the report to recognize location and species-specific differences in the evaluation of the relative importance of the factors fails to identify actual problems affecting anadromous salmonids in Oregon.

TECHNICAL INFORMATION REVIEW

A review of the scientific information and literature citations was completed to assess the accuracy and completeness of the document. This review involved comparing the information presented in the report directly to the conclusions and data presented in a sample of the original cited studies. The accuracy of selected data tables and figures, and a portion of the personal communication citations were also verified. The Department did not verify all of the cited scientific studies, but selected a portion of these citations to assess the overall accuracy of the document. The following discussion summarizes the findings of our information review (see Appendix A for a detailed review). These findings are presented as an overall summary preceding specific comments on each chapter of the report.

General Conclusions

A review of the scientific information presented in the report identified several problems with the document. These problems include: (1) a failure to base analyses or conclusions on information presented in the report, (2) inaccuracies in the statistical information presented in the report, (3) inaccurate interpretation or reporting of scientific studies, (4) failure to analyze data using rigorous and scientifically valid methods, and (5) incomplete summary of scientific information available for a topic. A brief discussion of these specific problems is as follows:

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Failure to Base Analyses on the Information Presented

The report is largely a compilation of statistics and information that lacks any direct correlation to the analyses and conclusions of the report. The use of statistics or information to evaluate the relative importance of the environmental and management factors is not documented nor apparent in the report. The conclusions appear to be derived from an independent, subjective ranking of the factors that is not based upon scientific information.

An example of this problem exists in the discussion of fish harvest. This section presents a variety of harvest statistics but does not provide analyses that evaluate the relative contribution of this factor to the decline of salmonids. The report eventually concludes, however, that overharvest is the greatest factor responsible for the decline and lack of recovery of Oregon's anadromous salmonids (Table R-1).

Information Inaccuracies

The report contains a significant amount of incorrectly reported information, and examples where the biology of fish populations in Oregon were poorly understood by the authors. Inaccurate reporting of fisheries related statistics were prevalent in both the tables and in the text of the report (see Appendix A). One example of the authors misunderstanding of Oregon's fisheries resources is the numerous references to pink salmon "declines". The report begins by noting that *"Oregon pink salmon are virtually nonexistent today..."* and attributes the "decline" of pink salmon to such factors as overharvest and mining. These conclusions are based on the absence of this species in ocean and inriver harvest statistics and does not recognize that pink salmon are not indigenous to Oregon. Pink salmon are intercepted in ocean fisheries off Oregon in odd-numbered years, and are occasionally observed straying into Oregon streams, but the normal distributional range of this species is from approximately Skagit Bay, Washington northward (Emmett et al. 1991).

Inaccurate Interpretation or Reporting of Scientific Studies

The report contains a number of examples where conclusions or data from the original studies were inaccurately reported (see Appendix A). The inaccuracies included: (1) citing conclusions that were not present in the original research, (2) citing only a portion of the original authors conclusions, (3) citing statements that were in direct conflict with the original study, and (4) citing information in a manner that was overtly discouraged by the original authors. A significant number of these inaccuracies were identified even though only a subset of the total literature citations were verified.

Failure to use Rigorous and Scientifically Valid Methods to Analyze Data

The report contained examples where information extracted from scientific studies were analyzed in a manner that was not scientifically valid. Incorrect conclusions were then derived from these calculations. For example, the questionable use of data was common in the discussion concerning the loss of salmonids to marine mammal predation. Calculations derived to estimate the annual consumption of salmonids by

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marine mammals for the entire state of Oregon (Table 2.2.7-2. and 2.2.7-3.) were based on questionable assumptions, incorrect estimates of marine mammal abundance and highly variable information that did not accurately portray the complex dynamics of predator-prey relationships.

Incomplete Summary of Scientific Information

The information included in the report is incomplete and selectively presented for several topics. In general, a significant amount of information is presented concerning harvest and Columbia River issues, but considering the amount of information on the topic, little is presented for fish habitat degradation. For example, research studies on the effects of forestry practices are numerous, but only a minor portion of these studies were referenced. Several major topics, such as water temperature and the effects of long-term riparian harvest on large woody debris abundance were inadequately discussed. Several important forest management studies were also ignored including the Oregon Alsea Watershed Study (Moring 1975a, 1975b; Moring and Lantz 1975) and the Carnation Creek Study (Hartman and Scrivener 1990, Holtby 1988). These studies are unique in their assessment of the long-term effects of forest practices on the production of salmonids.

An example where only a portion of the results of a study were presented was the discussion of the Tillamook Bay Erosion Study (USDA-SCS, 1978). In the discussion of this study, the authors misuse information to conclude that *"stream sediments from agriculture were twice that from forests...on a unit area basis..."* In making this conclusion, the report directly conflicts with conclusions of the original study which states:

> *"Erosion and sediment delivery rates on forest lands still make significant contributions to the problems of the basin. The mean annual gross erosion amounts to 286,245 tons. The mean annual fluvial sediment load is 51,602.6 tons from forest lands. These are 95.6 and 85.1 percent, respectively, of the basin totals."* (USDA-SCS 1978)
>
> *"The total sediment in the system is the crucial problem."* (ibid)

Chapter Summaries

MANAGEMENT FACTORS

Section 1.1 Harvest

The overall conclusion of this section is that overharvest is largely responsible for the decline of anadromous salmonids in Oregon. The major problems with this conclusion can be summarized into three general issues:

(1) an over-reliance upon Columbia River harvest and population status data to conclude that anadromous populations are depressed statewide due to harvest.

(2) failure to acknowledge the synergistic relationships of habitat alteration, harvest, and other factors to explain population declines.

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(3) limiting the comparison of "recent trends" to the period of the 1970's to 1990 is too short a timeframe to derive conclusions concerning the health of anadromous populations. The effects of increased regulatory restrictions on harvest, and natural variability in run sizes prohibit making definitive conclusions based upon this range of information.

In addition, the supporting tables and figures that report fishery harvest statistics contain a significant number of inaccuracies (see Appendix A).

Section 1.2 Fish Resource Agency Policies and Goals

This section describes management goals and trends in the escapement of Oregon chinook and coho salmon stocks, and fishery agency policies related to the management of these populations. The major problems within this section are as follows:

(1) declines in Oregon's salmonids are attributed to harvest and harvest management policies without recognizing that changes in the productivity of individual stocks (as reflected by stock-recruitment relationships) due to freshwater habitat degradation can influence spawning escapement. Changes in freshwater habitat productivity can synergistically contribute to the decline of salmonids when harvest management does not compensate for these changes.

(2) escapement information for chum salmon, steelhead and searun cutthroat were not presented due to lack of data on these species. However, the report uses escapement trends for coho and chinook to conclude that harvest is a primary factor in the decline of all Oregon's anadromous salmonids (Tables R-1, R-2 and 2.3-1).

(3) ODFW methods to estimate the escapement of coastal wild coho stocks are inaccurately portrayed.

(4) the report describes an ODFW Harvest Policy which does not exist.

(5) in describing the ODFW Wild Fish Management Policy, no acknowledgment is given to Habitat Policies which are an integral component.

Section 1.3 Hatchery Practices

This discussion is a general presentation of past hatchery management practices (largely based on Columbia River information) that is an inaccurate portrayal of the majority of current ODFW Fish Propagation programs. The report fails to note that many of the practices described have been discontinued. In addition, no information is presented that could provide the basis to rank the importance of this management factor to the decline of Oregon's anadromous salmonids.

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ENVIRONMENTAL FACTORS

Section 2.1 Water Use

This section discusses habitat loss and reduced salmonid production due to dam construction, fish passage problems, inadequate water diversion screening, water flow reductions and fish habitat modifications. The focus of these habitat issues is primarily limited to the Columbia River Basin, and very little information is presented for coastal tributaries. The following problems were identified:

(1) the loss of habitat due to blockages from dam construction is reported as one-third of the anadromous salmonid habitat in Oregon. This loss is largely restricted to the Columbia Basin. The report does not acknowledge that this problem is minor on coastal streams where significant anadromous production occurs.

(2) the discussion of upstream passage issues is restricted to information from the Columbia Basin.

(3) the scope of the current need to screen water diversions to prevent fish loss over-exaggerates the existing situation. The report implies that 55,000 water diversions are unscreened, so the loss of anadromous salmonids *"...must be in the billions."* The report does not recognize that of the 56,000 diversions reported, only approximately 4,000 occur where gamefish, or threatened or endangered nongame fish species are present. In addition, of these 4,000 diversions approximately one-fourth are presently screened. Of the 3,000 remaining diversions where screens are needed, a significant percentage impact only non-anadromous salmonids and/or nongame threatened or endangered fish species. The discussion should also be regionalized to reflect the relative importance of screening needs on fish bearing streams in different portions of the state.

(4) the discussion of water withdrawals and instream flow reductions is limited to the Columbia Basin. The relative importance of this issue to coastal watersheds is not assessed.

Section 2.2 Land Use

2.2.1. General

The report presents a historical perspective of human development, and a description of the land management and ownership patterns in Oregon. A substantial portion of this section is devoted to describing the negative affects of roads on stream habitats and the survival of salmonids. This discussion is accurate, but the report fails to acknowledge that a majority of road miles and road-related impacts occur in relation to forest management activities. The scientific studies cited as the basis for the discussion were primarily forestry studies.

The effects of riparian vegetation removal on water temperature, sources of large woody debris and nutrients, and streambank stability are presented as "general" land management concerns. The report does not attribute the relative importance of these activities to different land management activities.

2.2.2. Agriculture

The potential impacts of agricultural practices on salmonid production are attributed to irrigation, nonpoint pollution, erosion and grazing practices. In general, the report presents an accurate description of the potential impacts that these land management activities can have on salmonids. However, many of the "general" problems that are attributed to agricultural practices are equally pertinent to other land management activities. The following problems with the report were noted:

(1) the use of Oregon Department of Environmental Quality (ODEQ) nonpoint source (NPS) pollution data (ODEQ 1988) to imply that agriculture is the primary contributor to these problems is not scientifically based. The report appears to conclude that agriculture is the most important land management factor to NPS pollution because *"agricultural land use predominates monitored problem areas."* Assigning the relative importance of land management practices based upon the location of monitoring areas is invalid. The report does not acknowledge that upstream activities affect water quality in downstream (monitored) reaches. This discussion should have been placed in the "general" land management discussion as it is applicable to all land management practices.

(2) the agricultural discussion is largely focused on conditions in the Columbia Basin. The information should have been regionalized to assess the relative importance of the various practices to anadromous salmonid declines in different locations of the state.

(3) the report concludes that *"agricultural practices are currently the dominant land use practices...of concern for wild anadromous salmonid fish in Oregon."* While agricultural practices are a concern in certain regions of the state, no empirical information is provided to support this statement for the entire state.

2.2.3. Forestry

This section provides an incomplete review of the available scientific literature concerning the relationship between forest management and salmonid habitat productivity. The report fails to adequately present existing information for several important topics (large woody debris and temperature), attributes forestry-related studies and impacts to "other" land management discussions (roads and riparian vegetation removal), and ignores several important long-term studies of the affects of forest management on salmonid habitat and production. The report concludes that forestry is of limited importance to the decline of salmonids because current activities are being regulated by the Oregon Forest Practices Act. This conclusion does not recognize that past as well as current practices should affect the relative importance of these activities to the historical decline and lack of recovery of Oregon's anadromous salmonids. The following specific problems were identified during the review:

(1) the report does not incorporate several very important long-term studies of salmonids and forest management. Specifically, results from studies such as the Alsea Watershed Study and the Carnation Creek Study should be presented.

The discussion does not recognize the long-term changes in habitat productivity that have resulted from forest management activities.

(2) the importance of forest management activities to the long-term supply of instream large woody debris is inadequately discussed. Current shortages of this material are primarily attributed to past debris removal activities, but pertinent research concerning the influence of timber harvest in riparian areas to these shortages is not presented.

(3) the affects of forest road construction on salmonid survival should be presented in this section. Forest roads are a significant proportion of the total road miles in Oregon.

(4) the comparison of pesticide use in forestry and agriculture is not scientifically valid because the data used to make these comparisons does not include all forest lands. The original study reported pesticide use on US Forest Service lands only, and did not include other federal, state or private forest lands in the estimate.

2.2.4. Municipal-Industrial

This section is primarily a discussion of point source pollution discharges by municipal and industrial entities without any empirical evaluation of the importance of these factors to the decline of salmonids. In addition, the tabular information that is presented to summarize these pollution problems is inaccurate. A table listing the number of stream miles "adversely affected" by such parameters as low dissolved oxygen, bacteria, turbidity, elevated temperatures, etc. is presented in a manner that implies that municipal and industrial sources are the cause. However, the data in this table actually reflects an assessment of statewide nonpoint pollution problems from a multitude of land use activities. The report cited for this information (ODEQ 1990) indicates that municipal and industrial sources are a minor component of the pollution problems, and that the majority of stream miles affected are attributed to forestry and agricultural practices.

2.2.5. Mining

This section is a historical discussion of mining in Oregon with very little information presented concerning the effects of these activities on stream habitat or salmonid productivity. The information presented is inadequate to derive any conclusions of the relative importance of these activities to the decline of salmonids.

Section 2.3 Environmental Phenomena

2.3.1. Natural Phenomena

This section is generally an accurate description of the variability that natural events can exert on the survival and productivity of anadromous salmonids, and appropriately notes that the magnitude of the effects of these events can be increased by land

management activities. However, no information is presented to provide a basis to evaluate the importance of these events. There are several clarifications that should be included in the report:

(1) the report implies that El Niño events are relatively common in Oregon. In actuality, El Niño's of the magnitude to bring warm oceanic currents to the coast of Oregon are relatively rare: in the past fifty years this has only occurred four times (1941, 1957-58, 1982-83 and 1992).

(2) the report does not acknowledge that oceanic events, such as El Niño, can affect salmonid species at differential rates due to differences in offshore migration patterns. For example, north-migrating chinook and steelhead are affected differently than Oregon coho or south-migrating chinook stocks.

2.3.2. Predation and Competition

This section discusses the potential impact on anadromous salmonids from predation and competition with other wildlife such as marine mammals, birds and other fish species. Estimates of marine mammal predation and competition were based on questionable analytical methods. The information presented in this section was not adequate to evaluate the relative contribution of these inter-specific relationships to the decline of salmonids. The following problems were identified during the review:

(1) the report fails to recognize that most of the inter-specific relationships discussed are natural occurrences (with the exception of American shad establishment), and that the relative importance of predation and competition is likely influenced by human activities. For example, decreases in salmonid abundance due to other factors such as harvest and habitat degradation result in natural losses (predation and competition) becoming increasingly more significant. In addition, no evidence was presented to indicate that such interactions have increased above natural historic levels.

(2) the discussion of fish predation on juvenile salmonids is restricted to studies of the Columbia River where dam presence has a direct influence on predator-prey relationships. Similar predation rates are questionable for other watersheds in Oregon. However, the evaluation of the importance of this factor to the decline of salmonids does not recognize this regional variation.

(3) squawfish predation estimates are extracted from one study that may have over-estimated predation rates due to sampling design problems, and another study that estimated squawfish predation in the immediate vicinity of hydroelectric dams where the predation rates observed are much higher than the rest of the squawfish population.

(4) the discussion of competitive interactions with shad in the Columbia River is largely a hypothesis that is not substantiated by scientific research. The analysis fails to document the extent of spatial and temporal over-lap in estuary rearing habitat between juvenile shad and salmonids, and does not document whether food availability is limiting juvenile salmonid production within Oregon's estuaries. Interestingly, the report also does not note that juvenile shad are a prey source of juvenile salmonids in rivers and estuaries (Emmett et al. 1991).

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(5) estimates of marine mammal predation on salmonids are based upon "simple" mathematical calculations that do not adequately reflect the complexity of predator-prey relationships. In addition, these calculations are based on questionable assumptions, incorrect estimates of marine mammal abundance and population structure, and highly variable information. The variability of these estimates makes direct comparisons to fish harvest questionable.

(6) the estimates of marine mammal predation are largely extracted from studies of the Columbia River estuary and the Strait of Georgia (British Columbia) where salmonids were concentrated or available during a large portion of the year. These studies cannot be applied to estimate salmonid consumption by Oregon marine mammal populations over a broad geographic area. In addition, calculations of marine mammal predation often assumed that salmonids were available for 365 days of the year: this assumption is not accurate for Oregon.

CRITIQUE OF METHODS USED TO FORMULATE RECOMMENDATIONS

The most important part of the OFIC report is the ranking of the relative importance of a variety of management and environmental factors to the decline and lack of recovery of Oregon's anadromous salmonids. This information could provide the basis for prioritizing management efforts to facilitate the recovery of these populations. The importance of the document is, therefore, largely dependent upon the validity of this analysis.

The Department reviewed the methods used to rank the relative importance of the environmental and management factors, and assessed the validity of the conclusions derived from this analysis. The methodology employed to rank the factors may be best characterized by the following text from the report:

> *"Two separate subjective methods were used to rank relative mortality: rough increased mortality associated with factors studied and a matrix approach. Tables R-1 and R-2 reflect those ratings."*

Our review of Tables R-1 and R-2 indicated that these analyses were not based on empirical data. Table R-1 was created by an independent subjective ranking of the factors by the authors. Table R-2 was compiled using a matrix analysis approach (Table 2.3-1) but was also largely subjective. The fundamental problems with the authors matrix analysis methodology were: (1) the analysis was not stratified by location and species, (2) the impact of the factors were arbitrarily ranked, (3) some population impacts were redundant and were multiple measures of the same effect on salmonid populations, (4) the measure of a factors impact was arbitrary and was not based on a change in salmonid population abundance, and (5) the method used could not measure the impact of multiple factors acting simultaneously on a population. A discussion of these specific problems follows:

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(1) Analysis was not stratified by location and species

The analysis did not stratify the evaluation of the impacts of the factors on salmonid populations by region, or by species. The relative importance of a factor to the productivity of anadromous salmonids will vary by region and watershed according to the distribution and intensity of the respective factor. In addition, the impacts of a factor will vary for different species due to the life history requirements and biological characteristics of each species. Failure to incorporate these stratifications into the analysis lead to incorrect conclusions concerning the relative importance of the factors.

(2) The impact of factors were arbitrarily ranked

The criteria for assigning a relative score (1, 2, or 3; Table 2.3-1) as a measure of the population impact of each factor in the matrix was not documented, and appeared to be arbitrary. The basis for assigning these values was not related to the discussions of the various factors, or information presented in the report. Since the relative impact rating for a factor was the sum of scores for all impacts assigned to the factor, the rating was very dependent upon the scores that were assigned.

(3) Some population impacts were redundant

Some of the population impacts in the matrix were redundant and were multiple measures of the same effect on salmonid populations. In the analysis, a factor was often given several scores for the "biological population impacts" even though the impact actually only represented a single effect on the population. This redundancy over-weighted the impacts of certain environmental or management factors on salmonid production. For example, salmonids harvested in ocean fisheries were given scores for biological impacts titled: "direct mortality-young", "direct mortality-adults", "indirect mortality", "contributes to mixed fishery", and "contributes to reduced spawning escapement". These scores were then added to obtain a relative impact score. The analysis failed to recognize that the five impacts are synonymous and represent a single effect on salmonid production (reduced adult spawning escapement). Assigning a "harvested fish" to each of these categories resulted in that fish being counted five times, thus overestimating the actual impact of harvest.

Because the matrix analysis method relied upon a direct summation of impact scores (1, 2, or 3) to evaluate the relative importance of the factors, the ranking of the factors was directly dependent upon the number of matrix categories. The selection of these "biological population impact" categories was not supported by any information presented in the report. In addition, these categories did not accurately reflect the complex biology of anadromous salmonids. Using redundant impact categories and a summation method that is dependent upon the number of categories selected results in conclusions that are not scientifically valid.

(4) The measure of a factors impact was not based on changes in population abundance

The analysis method appears to be based on an assessment of the "increased mortality" that a factor can exert on a single life history stage of salmonids, and fails to base the

estimate of the relative impact on the total production of salmonids. This method ignores compensatory survival mechanisms, widely recognized as being important to the population dynamics of most species. To estimate the biological impact of each factor on salmonid production, the matrix method would require a mechanism to sum impact levels while recognizing that increased mortality at one phase of the life cycle can be compensated by reduced mortality at a subsequent stage. The total impact of a given factor on the productivity of the population should be represented by the relative change in the production of adult salmonids. For example, reduced spawning escapement will result in a lower production of juveniles, but if freshwater habitat is not limited the survival of these juveniles to the smolt stage will be increased because of reduced density-dependent mortality (a compensatory mechanism). The net effect on the total production of adults will be less than the direct reduction in juvenile numbers due to this compensation in survival rates.

(5) The method could not measure the effects of multiple factors

The matrix methodology could not measure the cumulative impact of multiple factors affecting a population simultaneously. The analysis was limited to an evaluation of the effect of a single factor on one aspect of salmonid life history, and failed to include a method to recognize synergistic interactions of multiple factors on total stock productivity. For example, the effects of a 60 percent harvest rate on coho salmon populations will vary markedly if ocean survival rates (smolt to adult) the previous year change from 8 percent to 4 percent. In addition, a particular harvest rate that is acceptable for a population living in a pristine basin will be unacceptably high if egg to smolt survival rates are reduced because of freshwater habitat degradation. Ignoring these complex relationships results in over-simplified conclusions that are not likely to accurately predict the relative importance of the factors.

ALTERNATIVE ANALYSIS APPROACH

To demonstrate the complexity of quantifying and evaluating the effects of various factors on salmonid production in a scientifically valid manner, the Department has developed an example of an alternative matrix approach. This approach is based upon a prediction of the relative change in adult salmonid production due to a variety of factors, and is consistent with concepts currently being used in life cycle modeling to weight the effects of various mortality sources on salmonid production in the Columbia River Basin. A major difference between this approach and the OFIC report matrix is that the relative importance of a factor, or combination of factors, is based upon the predicted change in total adult production of a species.

In this example, an array of biological impacts is evaluated by estimating changes in five population parameters: (1) adult spawners, (2) fecundity per adult, (3) egg survival, (4) juvenile survival, and (5) survival to adult. Each of these parameters could be further partitioned: for example, juvenile survival could be subdivided into fry survival, summer survival, over-winter survival, etc. The potential causes of biological impact affecting these population parameters are numerous and include such sources as sedimentation, increased stream temperature, predation and harvest. In our example, these causes are generically referred to by a numerical designation (Table 1). Associated with each cause of biological impact is a list of factors or activities that contribute to the identified impact. These factors would include the environmental and

management activities identified in the OFIC report, but this matrix recognizes that a specific cause of biological impact can be associated with more than one activity.

The effect of each biological impact in the matrix is presented as the relative survival change (percent) in each life history parameter. For example, if siltation reduces egg survival by 45%, the matrix entry would be -45%. If a factor has a direct negative impact on one parameter that results in a related change in another parameter, it would be reflected in the matrix. For example, if a 45% reduction in egg survival results in a 10% increase in juvenile survival because of reduced juvenile rearing densities, matrix entries would be -45% for egg survival and +10% in juvenile survival. This approach allows the incorporation of compensatory survival relationships in the evaluation of the environmental and management factors.

The final measure of the biological impact of each factor on salmonid production is the percent change in recruits to adult. With this approach, the evaluation is based on the change in total salmonid production that occurs because of the activity being evaluated. For a given factor, the recruits to adult (RTA) relationship is estimated under baseline and impacted conditions as:

RTA = (adult spawners) x (eggs/adult) x (egg survival) x (juvenile survival) x (survival to adult).

The percent change in RTA (PRTA) is then calculated as:

PRTA = -100 x [1 - (RTA impacted / RTA baseline)].

The empirical data used to calculate the percent change in salmonid production (PRTA) is not presented in the matrix. The purpose of the matrix is to present the direction and magnitude of changes in population parameters and production. A supportive table for each matrix would present the associated empirical data. The column and row headings of this table would be the same as the corresponding matrix, however the entries would be the empirical measures, under baseline and impacted conditions, of adult spawners, fecundity per adult, egg survival, juvenile survival, survival to adult, and recruits to adult.

The following table provides an illustration of the possible format of an alternative matrix using this methodology (Table 1). In the first column are the identified causes of biological impact and all of their various combinations (to examine cumulative effects). In the second column are the potential activities or sources that contribute to the identified impact. In columns 3-7 are the relative survival changes (percent) of the five population parameters. The final column reports the total relative change (percent) in salmonid production (recruits to adult) associated with the identified biological impact. To complete an accurate evaluation of the relative impacts of the various environmental and management factors, a separate matrix would have to be generated for each species and basin combination.

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Table 1. An example of an alternative matrix to evaluate the affects of various environmental and management activities on the survival of anadromous salmonids. This matrix follows the methodology discussed in the previous text.

Species: X
Basin: Y

		Biological Impacts (Percent Change) In:					
		Population Parameters				Production	
Cause of Impact	Factor or Source	Adult Spawners	Fecundity per Adult	Egg Survival	Juvenile Survival	Survival to Adult	Recruits to Adult
1							
2							
3							
1+2							
1+3							
2+3							
1+2+3							

The previous matrix example only considers three sources of biological impact. The analysis will become increasingly complex as the number of impacts being evaluated increases. In addition, the need to generate a separate matrix for each species and basin (or aggregation of similar basins) combination requires that a considerable amount of survival data be available for an accurate evaluation of the factors. Unfortunately, much of the necessary data is currently lacking for most species and basin combinations.

CONCLUSIONS

The Oregon Department of Fish and Wildlife has concluded that this report does not provide an adequate scientific analysis or justification to support the conclusions concerning the relative contribution of environmental and management factors to the decline of Oregon's anadromous salmonids.

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APPENDIX A

Technical Review Comments Concerning Information Presented in the OFIC Sponsored Report.

This appendix provides specific comments on the report compiled by Oregon Department of Fish and Wildlife (Department) staff. These comments provided the basis for the discussion presented in the ODFW review of this report. The appendix is organized in a manner consistent with the format of the OFIC report and, where possible, direct references to pages and tables of the report are specified.

MANAGEMENT FACTORS

Section 1.1 Harvest

Page 5, 1.1.1. Fisheries Resources

This section provides a general discussion of anadromous salmonid populations in Oregon. The following statements were inaccurate or misleading:

> *"...all salmonid populations in Oregon are depressed (see Table 1.1-1),..."*

Table 1.1-1 only provides a list of Columbia River populations and does not reflect the status of *"...all salmonid populations in Oregon..."* In reality, many Oregon salmonid populations are currently healthy, such as north coast fall chinook (primarily wild), upriver bright (Columbia River) fall chinook (primarily wild), Columbia River sockeye (all wild with very large runs in the 1980s), and upriver summer steelhead (Columbia River).

> *"...Chum, pink, and sockeye salmon populations are so low that they occur in the fishery only as incidental catches..."*

Pink salmon are not present in Oregon streams but are harvested in ocean fisheries: these fish are believed to be Puget Sound stocks. Occasional pink salmon are also harvested in the Columbia River, but these are believed to be strays from Washington or British Columbia streams. The average sockeye escapement is presently near the 75,000 fish goal, but recent runs were of such strength 1983-88 fisheries were allowed. Several recreational chum salmon fisheries exist on north coastal streams.

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> *"Pink salmon river migration runs occur only in odd-numbered years in Oregon."*

Pink salmon are not native to Oregon, and are only rarely observed in Oregon streams. This species is found in oceanic and coastal areas north of about 40° N latitude, and its normal distributional range is from approximately Skagit Bay, Washington, northward (Emmett et al. 1991). Ocean harvests do occur in odd-numbered years off Oregon, but these catches are comprised of fish from streams outside Oregon.

Page 6, 1.1.3. Historical Catch

Columbia River Commercial Fisheries (pages 6-7)

In this section, the authors attempt to describe historic Columbia River commercial catches. This discussion contains a significant number of data errors concerning the volume of fishery landings in the early years, especially for sockeye salmon (Craig and Hacker 1940, Cleaver 1951, WDF and ODFW 1992).

Decline of Run Size (pages 7-8)

In this paragraph the authors attribute a reduced Columbia River run size of salmonids solely to fishery harvest. This is substantiated by the following quote:

> *"...the commercial fishery described above has taken its toll on the run size of the Columbia River salmonid fishery."*

The basis of this conclusion is a comparison of salmonid run sizes prior to development activities on the Columbia River to current levels (13 million fish versus 1 million fish). This analysis does not recognize, nor does it mention, the effects of the development of the Columbia River Basin on these populations.

This paragraph also contains mis-represented information:

> *"...from a low of about one million fish in 1983 (ODFW 1991) to a high of about 4.5 million in 1976 (Gunsolus, 1977)."*

The authors compare the estimated run size entering Columbia River in 1983 (1.0 million) to the total production of Columbia River fish (ocean catch plus run returning) in 1977. The apparent source of this information is a report by ODFW and WDF (1991), but this cannot be verified.

Decline of Harvest (page 8)

This paragraph attempts to show that the decline in harvest occurred prior to the development of the Columbia River Basin. In fact, harvest declined little from the 1870s to the 1930s. Major declines occurred since the 1950s when development

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affected runs and fisheries were increasingly regulated (Cleaver 1951, WDF and ODFW 1992).

Indian Fishery (page 9)

In this paragraph, the authors attempt to compare NPPC estimates of tribal harvest in the early 1800s (5-6 million adult salmonids, annually) to harvests of the Celilo dip-net fishery in the 1940s and 1950s. The estimated landings for the 1940s and 1950s used as a comparison are under-estimated by 90-99%. The following examples highlight discrepancies in the data:

1956 Celilo Falls chinook harvest:
Report estimate - 4,000 lbs.
Actual landings - 635,000 lbs. (FCO and WDF 1971)

1941 Celilo Falls salmon and steelhead harvest:
Report estimate - 295,000 lbs.
Actual landings - 3,500,000 lbs. (FCO and WDF 1971)

Columbia River Sport Fisheries (pages 8-9)

These paragraphs accurately describe the fisheries, and appear to be paraphrases from ODFW's "Lower Columbia River and Buoy 10 Recreational Fisheries" annual report (Melcher and King 1991). It should be noted, however, that WDF and WDW are co-managers in Columbia River sport fisheries. ODFW does not complete all fishery monitoring as is implied in the third paragraph.

Coastal River Basins Sport Fishery (pages 9-10)

> *"In recent years, coho salmon escapement in most Oregon coastal rivers has offered only sparse opportunity for sport fishing."*

Coastal rivers offer excellent opportunities for sport angling, especially for fall chinook salmon. Coho angling opportunities are also good in several coastal systems, though anglers primarily target returning hatchery stocks due to higher success rates in these fisheries. The authors erroneously cite Nicholas and Hankin (1989) (actually Nicholas and Hankin 1988) in reporting that the harvest of adult chinook in many tidewater fisheries was several hundred fish annually from 1947 to 1960. Harvests in these fisheries were actually of the magnitude of several thousand fish.

Coastal River Basins Commercial Fishery (page 10)

These three paragraphs described commercial fisheries in Oregon's coastal rivers and estuaries that have been closed for 30 years or more. The chinook fisheries are described using Nicholas and Hankin (1988), erroneously cited in References. The description of the coho fishery is from ODFW's Coho Plan (ODFW, 1982).

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The description of the steelhead fishery is from ODFW's Steelhead Plan (ODFW, 1986). The authors erred by stating that the Steelhead Plan estimated annual commercial landings in the 1920s to be 100,000-120,000 fish. The plan simply stated that using an average weight of 8-10 lbs divided into landings produces commercial catch estimates similar to those of the present sport catch.

Ocean Troll Fishery (page 11)

A short, inaccurate, and incomplete description of the Oregon troll fishery is given in two short paragraphs. The third (and last) paragraph paraphrases (incorrectly) only several of 19 summary paragraphs in Van Hyning (1973).

Van Hyning (1973) provides a review of Columbia River fall chinook returns 30-60 years ago, and discusses reasons for their decline in the 1950s. The 1950s decline was attributable to increased ocean troll fisheries primarily in Canada. Van Hyning warned that "...the effect of the recent era of intensive river development was hardly covered in this analysis..." (ibid, p.77). Furthermore, Van Hyning emphasized that "...these conclusions cannot be extrapolated to the future and may not apply to other species, runs, or races of salmonids." (ibid, p. 82).

Analysis of Latter-Day Historical Catch (page 11)

These four paragraphs paraphrase some of the conclusions in McKernan et. al. (1950) relative to Oregon coastal coho 1923-48. McKernan lists three causes of coho declines in those years: 1) logging, 2) water flows, and 3) intensity of fishing. The authors paraphrase many of McKernan's comments relative to fishing, but only briefly mention the other causes with the following statement:

> *"...two other factors considered in the study, floods and logging, were found to be related to coho salmon abundance in Oregon."*

The authors conclude this section by stating:

> *"Thus, as in all the earlier fisheries, overfishing was found to be a major cause for the decline of all the commercial salmonid fisheries of Oregon between the 1920s and late 1940s."*

The authors reviewed no other historic reports to base this conclusion.

Page, 12, 1.1.4. Recent Catch

These two introductory paragraphs offer no useful information in comparisons of recent catch data for both sport and commercial fisheries. For example, 1990 harvests are compared to 1989 and to the 1978-90 average. The conclusion of the authors is that sport catch has declined slightly and the commercial catch has declined sharply. In fact, both fisheries show a stable or increasing trend with only 1990 being down (ODFW Salmon and Steelhead Catch Data, 1977-90; ODFW and WDF, 1991; PFMC 1991).

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Columbia River Fisheries (page 13)

The authors summarize Columbia River fisheries with a single paragraph comparing 1990 harvests to 1989 harvests. In this discussion, the authors have transposed two numbers for the 1989 catch (864,000 versus 846,000 actual). The next comparison is of 1990 harvests to the peak landings (several years between 1883 and 1928). Finally, they refer to their Table 1.1-10 which states that all Columbia salmonids except fall chinook are declining (please refer to the review of tables and figures later in this document). The discussion mentions closed seasons for summer chinook and sockeye but fails to acknowledge long-standing closed seasons for upriver spring chinook and lower river commercially-caught steelhead.

Commercial Net Fishery (pages 13-14)

These paragraphs review data contained in Tables 1.1-11, 1.1-12, and 1.1-13 (please refer to the review of tables and figures later in this document). The comparisons are mostly accurate but provide little useful information. The authors erred in the 1990 chinook catch as "only 640,000 chinook salmon were landed..." If this were true it would be the largest landing since 1948. Only 64,000 chinook salmon were landed in 1990. The authors have also confused the number of gill-net licenses with the number of fishermen. They describe the number of gill-net licenses as increasing slightly and then use the exact same data to mean number of fishermen, stating a range and then deciding there is a decline.

The authors compared the poor 1990 catch and effort (open fishing days and licenses) to the excellent 1986 catch and effort, noting there were only six more licenses in 1986, yet 4 less open days, and surmised:

> *"Reduced run size appears to be the cause of the reduced commercial catch of 1990."*

The 1986 Columbia River salmonid return was estimated at 3.2 million fish, the largest return since Bonneville Dam was completed in 1938. The 1990 return was the lowest since the early 1980's (ODFW and WDF 1991).

Indian Net Fishery (pages 14-15)

These four paragraphs describe treaty Indian commercial landing trends from 1960 to present peak catch years. This section accurately describes the demise of the tribal fishing grounds at Celilo Falls in 1957 ending tribal fishing that occurred for millennia but then goes on to compare their near zero catch in 1960 to the high catch level now. Tribal fishers did not perfect the technique of set-netting in slack water pools until mid-1960s.

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River Sport Fishery (page 15)

This one paragraph introduces four tables of sport catch information. Please refer to the reviews of Tables 1.1-16 to 1.1-19 later in this document.

Lower Columbia (pages 15-16)

The first three paragraphs describe the sport catch in the main-stem lower Columbia for each race or species of salmonids. In most cases the catch has declined over time. However, the authors have ignored increased angling season closures in the last 20 years as a contributor to this trend. Seasons in the early 1970s were open year round while recent angling seasons have been restricted to only January to March and August to December for salmon, and year round closures for wild summer steelhead.

The last paragraph describes a declining catch rate for lower Columbia sport anglers based on Table 1.1-17. A review of this table (discussion to follow) shows that the angler trip totals the authors used included sturgeon and shad anglers (fisheries that have grown immensely in recent years). Including non-salmonid anglers in this comparison provided a greater than 50% under-estimate of salmonid catch rate. Thus the author's concluding statement is misleading:

> *"These (declining catch rates) imply a reduction in run size".*

Buoy 10 (pages 16-17)

These three paragraphs compare highs and lows in harvest during the 9 years of this fishery (Table 1.1-19). This discussion does not acknowledge the effects of closed seasons, catch quotas, in-season closures, or concurrent adjacent ocean fisheries on these harvest statistics.

Coastal River Sport Fishery (pages 17-18)

This section provides comparisons of annual variation in sport catch figures, all from Table 1.1-21. These comparisons are especially meaningless since the data being compared is from only a 13-year period (1978-90).

Ocean Troll Fishery (page 18)

This section provides comparisons of troll catch statistics contained in Table 1.1-22. The discussion does not acknowledge the effect of harvest quotas or seasonal regulation on the fishery catch or effort trends.

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Ocean Sport Fishery (page 19)

This section provides a comparison of ocean sport catch statistics from Table 1.1-23. Again, no discussion is provided concerning the effects of harvest quotas or seasonal regulations on the fishery catch or effort trends.

Summary (pages 19-20)

A summary of the annual catch variations described for the eight fisheries is presented on pages 13-19. The theme of the summary is that Oregon's salmonid fisheries have declined in recent years. This assessment combined with the escapement record, *"...which will be presented latter* (sic) *in the report...",* indicates to the authors:

> *"...that Oregon's salmonid stocks are not presently in good biological condition."*

The discussion within this section of the report never mentions that annual management actions directly affect catch magnitudes. If management had allowed unrestricted fishing and catches were high relative to prior years, would these increasing catches indicate Oregon's salmonid stocks were in good biological condition?

Page 20, 1.1.5. Regional Catch

This section describes declines in Pacific Coast fisheries based on Figures 1.1-11 to 1.1-13, data that were not verified as the source is not listed in the References. Based on these data, the authors attribute the supposed recent declines to environmental factors in the ocean.

The remainder of this section is a discussion of Poon and Garcia (1982), a report for a utilities consortium about the effect of fishing pressure, hydropower development, and irrigation withdrawal on chinook salmon. It is unclear how this report is relevant to a section on regional catch.

Page 22, 1.1.6. Indirect Effects of Harvest

Shaker Mortality (pages 22-23)

The authors present two different types of fishing mortality and they erroneously attribute both types to "shaker mortality." The authors also incorrectly apply shaker mortality estimates to total salmonid landings. A review of these issues follows:

> *"Shaker loss in ocean fisheries was extensively reviewed by Ricker (1976) who concluded that one additional fish is killed for every two legal fish landed and reported..."* (emphasis added)

> *"Boydston (1972) estimated the shaker mortality...to be 43 percent of the reported chinook catch."* (emphasis added)

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> *"The U.S. Fish and Wildlife Service (1983) uses a shaker mortality rate for Klamath River fall chinook...of 40 percent of the reported catch."* (emphasis added)

The estimates from these studies actually refer to the proportion of sublegal fish that are killed for every legal fish landed and reported. These estimates are not mortality rates for fish that are encountered, caught and released (i.e. shakers).

> *"Recent studies of the ocean troll fishery in Alaska (Wertheimer, 1988) estimated a hooking mortality rate of about 25 percent for chinook salmon."*
>
> *"PFMC assumes a shaker mortality of 30 percent from the use of barbed hooks and 26 percent for barbless hooks."*

These estimates refer to hooking mortality rates for fish that are encountered and released, and are appropriate measures of shaker mortality. However, the authors failed to specify to which species the PFMC estimates referred. It is important to note that these estimates will vary by species, fishery location, gear type (as is apparent in the PFMC estimates), etc..

> *"The values presented above suggest that shaker mortality is between 25 to 50 percent of the ocean catch."*
>
> *"From the PFMC and USFWS data collected from Oregon and northern California, an annual shaker morality* (sic) *value of between 30 and 40 percent seems appropriate for Oregon."*

The authors erroneously combine estimates of the proportion of sublegal fish that die for every reported fish landed with estimates of fish that die after being encountered and released (shaker mortality) to derive a range of "shaker loss" estimates. These different types of fishery mortalities are not synonymous, and cannot be combined into a single range estimate.

The authors also combine mortality estimates for different species into one generic estimate. The mortality rates can vary substantially for different species and sizes of fish. It would have been more appropriate to present species-specific shaker mortality estimates over a number of years to more accurately portray the range of possible estimates.

The Pacific Salmon Commission reviewed all available literature on hooking mortality for commercial troll chinook fisheries and concluded that a reasonable estimate of this mortality was from 20 to 30 percent (PSC, 1987). These estimates correspond with the study by Wertheimer (1988) and are substantially less than the range estimate presented by the authors. The 30 to 40 percent estimate by the authors does not seem "appropriate".

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> *"Applying a shaker mortality of this value* [30 to 40 percent] *to the 582,000 salmon landed in Oregon during the 1990 ocean commercial troll and recreational fisheries adds an additional mortality of 174,400 to 232,500 fish to the 1990 ocean population (Table 1.1-24)."*

This analysis is erroneous. Shaker mortality estimates apply to the loss of fish that are encountered and released in a fishery, and cannot be applied to estimate the fish lost as a proportion of the total landings. Shaker mortality estimates are only applied to the number of fish encountered and released. They cannot be estimated without first estimating the number of sublegal fish or non-target species encountered by a fishery. For the author's estimates to be accurate (*174,400 to 232,500*), the fisheries would have needed to encounter and release 582,000 salmon (assuming that 30 to 40 percent shaker mortalities are accurate).

Applying estimates of shaker mortality to total fish landings greatly over-estimates the loss of salmonids. For example, if a troll fishery harvested 100,000 legal fish in a season and encountered and released an additional 50,000 fish, applying a 30 percent shaker mortality rate to the total landings would estimate a loss of 30,000 additional fish. In actuality, the loss would be 15,000 fish (30 percent of 50,000). In the previous example of PFMC shaker mortality estimates (30 to 26 percent, by gear type), the hooking loss estimates are applied to estimates of the number of fish encountered and released by the fishery, not to the total landings.

The authors erroneously apply a generic range of mortality estimates derived from commercial troll fisheries to the estimate of total 1990 landings that includes harvest by recreational anglers. Commercial and recreational ocean salmon fisheries differ greatly in fishing methods and gear. It is inaccurate to apply mortality estimates from commercial fisheries to recreational salmon landings.

To correctly estimate the incidental loss of salmonids during ocean fisheries, the authors should ensure that: (1) the appropriate type of fishing mortality estimate is being used, (2) fishery data is stratified by angler-type (commercial versus recreational), (3) estimates are stratified by gear-types (barbed versus barbless hooks, etc.) (4) mortality estimates are stratified by species, and (5) other factors such as fishery location, time of the year, encounter rates for non-target species and sublegal fish, etc. are considered.

Dropout Mortality (page 23)

> *"...it seems reasonable to assume an annual dropout mortality rate of between 4 and 8 percent for the Columbia River commercial net fishery."*

The authors estimate these dropout mortality losses based upon information from the Klamath River tribal fishery, and the Puget Sound gill-net fishery. There have been no studies of gillnet dropout in the Columbia River to substantiate these estimates. Gillnet dropout is believed by ODFW to be low in the Columbia River fishery, and the mortality rate varies considerably by fish species, gillnet type, and by time of the year. The authors do not account for this variability, and do not state whether the fisheries evaluated for the dropout mortality estimates were conducted with similar gear, under similar environmental conditions, or targeted similar sizes and species of salmonids.

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In-River Sport Fish Mortality (page 23)

> *"The data presented suggest that it would be reasonable to assume a minimum loss rate of between three and nine percent for the inriver fisheries of Oregon."*

The authors base these loss estimates on steelhead studies in British Columbia, and note that ODFW applies these estimates to Oregon's catch and release program for wild winter steelhead. The ODFW believes that hooking mortality is approximately 3 percent when barbless hooks are used (a requirement for all Oregon catch and release streams). Approximately half of Oregon's steelhead streams are now regulated as catch and release fisheries. The authors fail to note that this mortality (3 percent) would only apply to fish that are released, which is currently estimated as about 25 percent of the steelhead catch.

The major problem with this discussion is the authors application of these hooking mortality losses to the total 1990 Oregon inriver harvest of salmonids. This analysis fails to recognize that the majority of these fisheries are not regulated as catch and release, and that a majority of the fish landed are retained. It is erroneous to apply catch and release hooking mortality estimates to fisheries that are not regulated in this manner, and where fish are not regularly released. The estimates provided in this report are likely to be significantly greater than the actual hooking mortality loss.

Page 24, 1.1.7. Out-of-State Harvest

This section attempts to describe oceanic migration patterns of Oregon salmonids, and the interception of these fish by out-of-state marine fisheries. The section is technically weak and most of the conclusions are erroneous.

> *"Few, if any, Oregon-produced summer chinook and spring chinook salmon from the Columbia are caught in out-of-state fisheries."*

This statement is false. Oregon has no Columbia River summer chinook. Spring chinook are caught in Canadian and Southeast Alaska fisheries (35% of Willamette spring chinook from 1980-90 were caught in these northern fisheries).

In discussing Vreeland (1989) the authors mix relative fishery contribution of "four brood years" with total harvest over a "four-year period." This analysis is not scientifically valid as presented. Furthermore, they err when they claim that the entire Columbia River catch of hatchery fall chinook (21.9% of total) is made by citizens of Oregon. About half of the Columbia catch is by Washington citizens.

> *"Thus, 73.4 percent or 749,000 of these Oregon produced fish were lost to harvests outside the state."*

Columbia hatchery fall chinook (tules) are produced in seven Washington, three federal, and only three Oregon hatcheries. Most of these hatcheries are federally funded. The Canadian catch of these fish is supported by the U.S. Section to the Pacific Salmon Commission.

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> *"No data are available on the contribution and distribution of wild fall chinook salmon from the Columbia River. But it probably is similar to that observed for these hatchery fish."*

This statement is erroneous. Columbia River wild fall chinook (lower river wild and upriver brights) are far more northern in their oceanic range and there is considerable data available from coded-wire tagged fish. For example, ODFW's salmon manager, Dr. Donald O. McIsaac, has studied Lewis River fall chinook and published the results (McIsaac 1990).

The authors claim *"...no specific catch data were found"* regarding the contribution of coastal chinook and coho to out-of-state fisheries. Considerable information is available especially in Pacific Salmon Commission documents.

Page 24, 1.1.8. Mixed Fisheries Issues

This section is a discussion of mixed stock fishery issues. The entire theme is that mixed stock fishing will cause less abundant stocks to decline and *"...possibly become extinct."* The authors use several examples:

> *"It is easy to understand how declining stocks like summer chinook salmon or Snake River sockeye salmon can be depleted in an ocean mixed fishery...."*

Summer chinook inriver fisheries have been closed for nearly 30 years, the ocean harvest on these fish is light, yet these fish continue to decline in the absence of harvest. Also, Snake River sockeye have been nearly completely protected since the Snake River dams were completed in the 1970s yet these stocks declined to near zero returns. The Department objects to the suggestion that harvest caused the decline of these Snake River fish.

The authors provide another conclusion based upon only a partial analysis of the reason for stock declines. The authors portray harvest rates on Columbia River hatchery coho (average of 88%) as being excessive (as compared to the OCN MSY rate of 69%) and conclude with the statement that this *"...harvest rate should be closer to zero if the population* [lower Columbia wild coho] *is to survive."* This simple conclusion provides no mention of the potential affects of reduced stock productivity on these declines due to human-caused habitat changes.

The weakness of this analysis is evident in the discussions of lower Columbia coho, Snake River summer chinook and Snake River sockeye.

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> *"Thus, this mixed fishery has significantly contributed to the decline of wild coho salmon in Oregon."*

The authors conclude the discussion of Columbia River coho salmon harvest with this statement applied to all coho populations in Oregon. An analysis of the effects of mixed-stock fishery harvest on Columbia River hatchery populations is not an applicable information base to make conclusions on the decline of all coho populations. These hatchery stocks are managed for a much higher harvest rate than are coastal wild populations. Ocean fisheries are managed with the intent of targeting on Columbia River hatchery coho stocks while attempting to minimize the interception of wild coastal stocks. In addition, Columbia River coho are intercepted in the ocean fisheries, in the intensive Buoy 10 recreational fishery, and in an inriver gill-net fishery. Coastal stocks are generally only exposed to the ocean fishery, with minor harvest during inriver sport fisheries. A conclusion which fails to recognize that these coho salmon stocks are managed with different objectives is false.

Page 26, 1.1.9. Terminal Fisheries

Similar to the previous section, the authors provide a discussion of terminal fisheries that portrays these fisheries as being *"...the opposite of mixed fisheries."* Several examples are offered as proof that terminal fishing is better than ocean fishing including statements that ocean fisheries catch immature chinook, and that *"...the incidental morality* (sic) *rate of gill net fishing was four to eight percent compared with the 30 to 40 percent of trolling."* The immature chinook discussion is attributed to Nicholas and Hankin (1988), wrongly listed in the references section. The incidental mortality rates are not substantiated by the authors (please refer to our previous discussion and the review of Table 1.1-24 concerning errors in these estimates).

In proposing that terminal fisheries be instituted as a better management tool for anadromous salmonid harvest, the authors should include a discussion of existing Oregon statutes (e.g. ORS 509.216) that prohibit certain terminal commercial fisheries from most Oregon waters.

Section 1.2 Fish Resource Agency Policies and Goals

Page 28, 1.2.2. Spawning Escapement

Columbia River Stocks (pages 28-29)

The reference for the status of the 754 populations was missing from the references section and, therefore, could not be verified. The Department believes that the information may be false.

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The following statements were found to be inaccurate or misleading:

Coastal River Stocks (pages 29-30)

> *"A similar evaluation of escapement data for the coastal river basins collected between 1968 and 1984 (NPPC, unpublished) showed that of 173 populations,..."*

It is not clear to which populations this paragraph and subsequent paragraphs refer. The data are not presented in the report and are referenced as unpublished.

Summary (pages 30-31)

> *"Similar decreases in escapement observed between coastal hatchery populations and wild populations could be explained by Nickelson's (1986) findings that coastal hatchery coho salmon had low ocean survival when hatchery smolt numbers were high....The success of hatchery fish in the Columbia River Basin appears to contradict Nickelson's (1986) findings for coastal hatchery stocks that showed poor ocean survival when released in large numbers."*

The paper by Nickelson (1986) is misrepresented. This paper did not find a relationship between decreased survival of coastal hatchery coho salmon and numbers released. In fact, just the opposite, the paper concluded that survival of hatchery coho was unrelated to numbers of smolts released. The paper also didn't separate out coastal hatchery stocks (except those released from private hatcheries).

> *"...annual number of coastal hatchery smolt releases has recently been relatively low, 15 million to 20 million...smolt releases had been much higher in the late 1970s and early 1980s when they exceeded 60 million fish annually for coho salmon alone (Nickelson 1986)."*

The smolt release values are inaccurate. They are too high to be coastal hatchery releases. The hatchery coho salmon smolt release numbers presented in Nickelson (1986) were for all public hatcheries contributing to the Oregon Production Index area (Columbia River and Oregon coastal combined) and for private hatcheries. The total of these two groups never exceeded 60 million in any one year, as claimed.

Page 32, 1.2.3. Escapement Goals

Coastal River Goals (page 33)

> *"Annual estimates of coastal coho salmon spawning escapement are derived in aggregate for the stock through spawning ground index surveys of three coastal lake basins (Cooney and Jacobs, 1990)."*

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This statement is incorrect. Estimates of coho salmon spawning abundance are derived from index surveys in 14 basins plus 3 lake basins, not just the 3 lake basins as indicated in this paragraph.

Page 34, 1.2.4. Spawning Escapement and Return to Rivers

Columbia River Goals (page 34)

This section includes erroneous information. The McNary Dam fall chinook escapement goal for 1991 was 45,000. The escapement range of 30-45,000 is an oversimplified description of the Willamette spring Chinook escapement goal over Willamette Falls, not into the Willamette River.

Coastal Rivers (pages 35-36)

The following statements were found to be inaccurate or misleading:

> *"Spawning escapement of Oregon coastal coho salmon in 1990 was only 69,000 fish, just 43% of the goal..."*

The actual coho salmon escapement estimate for 1990 is 104,200 (not 69,000 which was listed as preliminary by PFMC (1991) and should have been foot-noted as such). The 1990 escapement was 65% of the goal, not 43%. (Source: ODFW OCN database, Rod Kaiser, Ocean Salmon Management, Newport, OR).

> *"...in each year that the escapement goal for coastal coho salmon was not met, catch numbers exceeded the escapement goal number by a factor of from two to five..."*

This statement is misleading because the catch referred to was comprised primarily of hatchery fish from the Columbia River. The comparison of this catch estimate with escapement of wild fish to coastal streams is irrelevant. A relevant comparison would be the ocean and coastal tributary catch of OCN compared to OCN escapement. Ratios of catch to escapement for OCN coho salmon since 1980 range from 0.4:1 to 3.5:1 and have averaged 1.4:1, or an average harvest rate of 58%.

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> *"In the past, the number of spawners from the three coastal lake basins was expanded to determine escapement for the entire Oregon coast. It now appears probable that there was an overexpansion of spawning densities from the index surveys. This over expansion of spawning densities led to inflated estimates of spawners, stock recruitment, and escapement goals, and is believed responsible for underescapement and overharvesting of coastal coho salmon. PFMC is presently revising the method to estimate future spawning escapement for coho salmon..."*

This paragraph is a total misrepresentation of the methods of estimating coho spawning escapement, the conclusions of PFMC (1992), and the work ODFW (not PFMC) is doing to investigate the current methods to estimate spawners. Specifically:

1. Estimates of coho salmon spawning abundance are derived from index surveys in 14 basins plus 3 lake basins, not just the 3 lake basins as stated in this paragraph.

2. Preliminary data indicate that in years of very low escapement, estimates of spawner abundance derived from the standard index streams are higher than estimates derived from random surveys. Research into better methods to estimate spawning escapement were initiated and are being conducted by ODFW, not PFMC, as part of a continuing process to improve coho salmon escapement estimates that began in 1980 [*see* Beidler and Nickelson (1980) and Solazzi (1984)]

3. If estimates of spawner abundance were inflated, they would result in inflated stock recruitment and escapement goals, but would not result in underescapement and overharvest because the relationship between catch and escapement would remain the same (since catch is estimated directly from escapement) and the MSY harvest rate would remain the same. The net result would simply be that we would have fewer fish (both catch and escapement) than we originally thought.

Columbia River (pages 36-37)

The goals listed for spring chinook are not wild fish goals, but rather an aggregation of wild and hatchery fish.

The lower river fall Chinook goal is not 17,000 adults. The only Lower Columbia wild goal recognized is 5,700 for the North Lewis River. This goal has been exceeded in every year of record. Data in Table 1.2-11 does describe wild fish, even though the text does not make this distinction.

> *"In 1990, spawning escapement goals were met for only three of eight populations of wild anadromous salmonids in Oregon."*

This statement is incorrect for the following reasons:

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1. Three of the eight salmon populations analyzed are not wild populations based on the data used (Columbia River spring, summer, and Upper River fall Chinook).

2. Two of the populations are not Oregon populations: Columbia River sockeye spawn in Washington; Snake River sockeye are from Idaho.

3. Only one of the eight populations analyzed, OCN coho, correctly fits the claim of a wild population not attaining the escapement goal.

Page 38, 1.2.5. Production Harvest Policies

Management Agencies (pages 38-39)

"Harvest of Columbia River salmonids is managed by ODFW under the Columbia River Management Plan."

The Columbia River Compact manages commercial fisheries in the Columbia River. Oregon has one vote in this Compact.

"State regulation within territorial waters (0-3 miles off shore) are not required :o follow PFMC regulations."

This statement is incorrect. The State of Oregon has twice been preempted by the Department of Commerce for opening fisheries within state marine waters that were inconsistent with PFMC regulations for waters 3-200 miles offshore.

"The Columbia River Management Plan is a litigation settlement..."

The citations for this statement (ODFW, 1987, 1988) are incorrect. The proper citation is the U.S. District Court legal description.

Harvest Policy (page 39)

It is unknown how the authors determined that the harvest policy cited is the ODFW *"harvest management policy"*. ODFW has no documented harvest policy with this degree of specificity.

Chinook Salmon (pages 39-40)

The harvest rate data on which the authors conclusions are based are false. Also, ocean harvest rates for Columbia River chinook are wrong, therefore, the total harvest rates are wrong. The largest error is for 1987-89 Upriver fall Chinook. The 1961-69 ocean

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harvest rates for coho seem substantially high as well. Therefore, concluding statements about the effect of harvest rates on populations are also false.

Coho Salmon (pages 40-41)

> *"The Columbia River coho salmon run, which has about five percent wild fish, is managed for the maximum production of the hatchery component (Crammer* (sic) *et al., 1991)."*

The Columbia River Compact considered Clackamas River wild coho in management decisions to regulate the commercial gill-net fishery in 1991.

Page 42, 1.2.6. Present Wild Fish Management Policy

A paragraph is presented on each of the major sections of the policy that were approved in 1990, with the exception of the section on habitat. Statements to the effect that ODFW "shall oppose habitat degradation that causes a population to experience a decline in abundance..." [OAR 635-07-527 (2)] have been left out of the discussion. In addition, the 1990 version of the policy was updated and expanded in 1992.

Section 1.3 Hatchery Practices

Page 47, 1.3.2. Hatchery Culture Practices

Since 1977, ODFW researchers have developed an extensive data base of survival and hatchery practices that guide hatchery programs. The authors make no mention of studies published by ODFW scientists on these subjects [for example: Johnson et al. 1990 and Solazzi et al. (1991)].

> *"Current hatchery practices commonly maintain fish in an unnatural, stressful environment."*

This statement implies that most hatchery fish are raised in a stressful environment. This is not true. In some isolated instances fish may be stressed for short periods of time due to crowding or low water flows and consequently low dissolved oxygen levels, but this is not the common rearing practice at our present hatcheries. The Department generally restricts the loading levels in rearing ponds and routinely monitors dissolved oxygen levels in the outfall of hatchery rearing ponds.

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> *"Hatchery conditions may result in predisposing factors that enhance the susceptibility of juvenile hatchery salmonids to stress and subsequently increased rates of infectious diseases "* (emphasis added)

In isolated instances this statement is true, they may, but the statement gives the impression it is standard hatchery practice: this is not true.

> *"The ODFW's ability to recommend time, size, and location of hatchery fish releases has been hindered by an inadequate data base and inconsistent results from past studies, attributed to poor experimental design or disease problems."*

The Department is presently building a data base that assists in determining the best times and sizes for release. True, disease is a problem in some cases. The major factor contributing to the variability of the data is variation in environmental factors occurring in both fresh water and marine areas over which man has no control. Hatchery factors over which the Department has control contribute to a very small part of the variability in the results from year to year in fish survival.

Page 48, 1.3.3. Genetic Risk

The word "may" is used four times in this section in quotes and only serves to provide a possibility of some action occurring, but provides little conclusive evidence to the discussion.

Page 48, 1.3.4. Transfers

This paragraph discusses primarily past practices with little emphasis on the present.

Page 48, 1.3.5. Outplanting

> *"...this practice is extensive and has persisted for decades."*

This statement may be true for trout stocking programs, but it is certainly not true for most anadromous salmonids. Outplanting has been greatly reduced in recent years except for fish transported to acclimation sites such as coho to net pens in Youngs Bay or steelhead to acclimation sites in N.E. Oregon.

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> *"Coho salmon outplanted into the lower Columbia River are the progeny of numerous previous stock transfers over multiple generations and may carry the genetic material of a broad spectrum of ancestral stocks, often from different watersheds: some were not even of Columbia River origin."*

Present ODFW lower Columbia River hatchery coho stocks were all derived from the Early Toutle coho stock. This group of fish is regarded as a single unit. No attempts are made to utilize native coho brood stocks from these hatchery streams as very few, if any, native coho presently exist in these areas. In the late 1970's, there were some small experimental groups of tagged Late Cowlitz coho released in Scoggins Creek, a tributary of the Willamette system. These releases were not successful and the practice was discontinued. Small experimental crosses of 1979 brood coho at Big Creek included stocks from the Smith and Soleduck Rivers. These experimental groups were less than 10,000 fish per tagged group. The adults returning from these experimental releases were destroyed and the experiments discontinued. Present hatchery practice is to utilize native broodstocks for development of hatchery releases for ODFW hatchery production. Stocks may be collected from a separate watershed, reared in a hatchery and then returned to the parent stream for release.

Outplanting of coho presmolts was extensively conducted due to legislative directive in the 1980's. The practice was evaluated as unsuccessful and potentially harmful to the native wild spawning populations so the practice was discontinued.

The following passages are inaccurate:

> *"Cramer et al. (1991), report that outplanting and subsequent spawner abundance on 15 test and 15 control streams on the Oregon coast were monitored for three years."*

The study referred to was conducted over a period of 6 years (not 3 years) and was published by Nickelson et al. (1986), not Cramer et al. (1991).

> *"A major component of the ODFW coho restoration program, however, is the supplementation of wild coho in coastal streams with hatchery presmolts..."*

The "Coho Restoration Program" did use hatchery presmolts to supplement wild coho. However, this program took place in 1980-82 and was terminated as a result of the evaluation conducted by the Research Section of ODFW and reported by Nickelson et al. (1986).

Page 50, 1.3.7. Diseases

> *"Hatchery fish act, during this low level of infection, as reservoirs of pathogens that are released into the streams."*

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Wild fish that are allowed to move above hatcheries also act as reservoirs of infection to fish reared in hatcheries.

> *"...hatchery reliance on antibiotics may result in mutant strains of pathogens...antibiotics may not eliminate infections in hatchery fish, but merely maintain mortalities in the hatchery at an acceptable level."*

Again, the authors report possible problems as events which "may" occur without any substantiating evidence.

Page 51, 1.3.8. Hatchery Production for Harvest

There appears to be two different opinions in the fishery community as to the purpose for hatchery fish production. One opinion considers that hatchery fish should only be used to maintain native wild populations of anadromous salmonids and that fish production should be dependent entirely on wild fish.

The other opinion considers hatchery production for supplementation of fish to supply both sport and commercial fisheries that could not exist if they had to depend solely upon natural fish production.

Both goals are correct for some streams but neither is appropriate in all situations. Each is a management tool to be used in a specific instance to accomplish a specific management goal.

ENVIRONMENTAL FACTORS

Section 2.1 Water Use

Page 56, 2.1.3. Upstream Passage - Gross Habitat Area Losses

> *"Estimates of Columbia Basin salmon and steelhead spawners based on habitat availability before 1850 are 6.2 million salmon and 8.3 million steelhead (NPPC, 1986)....At a 2:1 catch to escapement ratio, this is an annual loss of 6.8 million salmon and 9.2 million steelhead to fisheries on a sustained basis."*

The total Columbia Basin losses cited from NPPC 1986 appears to be incorrect: the authors cite a loss of 7.9 million salmon and steelhead. The loss of salmon and steelhead estimated by NPPC above Bonneville is between 8 and 16 million fish annually (NPPC 1987). The authors also incorrectly apply a catch/escapement ratio to the NPPC data in order to estimate losses to fisheries. However, the NPPC data is a total production estimate that *includes* harvest.

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> *"Total stream miles are another way to evaluate gross area losses....These figures include tributaries and yield a more conservative one-third stream mile loss estimate for the Columbia Basin."*

Estimates of miles of stream lost in the Columbia Basin are more realistic, not conservative, estimates of habitat loss than estimates based on square miles. This should be obvious: there are many square miles of desert in Southeast Oregon with very few miles of stream. Also, White Salmon River is in Washington, not Oregon.

> *"Gailsville [sic] Reservoir (upper Cow Creek, Umpqua River) blocks approximately 15 miles of anadromous salmonid habitat (Lumas [sic], 1992)."*

Both "Loomis" (an ODFW district biologist) and "Galesville" are misspelled. Furthermore, a retired PacifiCorp employee, J. Haenel, is also cited in this paragraph twice. This citation is then spelled differently in the list of references, as "Hanel". Which is the correct spelling?

This section also makes reference to reports by "PNRBC" and "USAED", which are listed in the References section but not spelled out. These references should be spelled out in the Reference section because they are not universally understood in the fisheries community.

> *"Gross anadromous salmonid habitat losses in Oregon due to water development projects are about one-third of the historical native anadromous habitat..."*

The authors conclude this section with a statement that fails to acknowledge that these habitat losses are not distributed evenly across all regions of the state. This statement does not specify that the importance of habitat blockages to the decline of salmonid populations is relatively minor in coastal tributaries, and that an evaluation of the relative importance of this factor should be regionalized to recognize this fact.

Page 57, 2.1.2 Upstream Passage Effectiveness

> *"Fish passage problems at Oregon City Falls,...were recognized in the 1970s (PNRC, 1976).*

The source of this information is not listed in the reference section, unless possibly both the organization's abbreviation and the year of publication are listed incorrectly.

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> *"Mainstem Columbia and Snake River dams had significant upstream passage problems as well. Gibson et al., (1979), estimated a 20 percent adult mortality rate associated with passage at John Day Dam, and Weiss (1970) estimated 13 percent associated mortality at Bonneville Dam and 12-25 percent at The Dalles Dam. Similar adult mortality (loss) rates may apply at older fish passage facilities elsewhere in Oregon.... 'The design and engineering of passage facilities have evolved as successes and failures brought more understanding about sensitive interactions between biological and engineered systems' (Rainey, 1991)."*

The report implies that the adult losses at Bonneville, the Dalles, and John Day dams can be attributed to outdated fish ladder designs - this is not true. The high mortalities at these dams during the 1960s and 1970s were due to high flow and forced spill prior to Columbia River Treaty storage. The cited studies (Gibson et al. 1979 and Weiss 1970) showed that adult losses were highest during high spill years due to fallback and delay.

In this paragraph, both Gibson and Weiss are cited but are not included in the References section. At the end of this paragraph, "Rainey, 1991" is quoted but is also missing from the References section.

The second paragraph of page 58 incorrectly describes the 1991 Fish Passage Center (FPC) Annual Report (FPC 1991). The following statements were inaccurately reported:

> *"Loss of adult fish was higher than normal in 1990 based on individual dam counts..."*

The Fish Passage Center report does not state that "higher than normal losses of adults" occurred. Rather, FPC (1991) reported that "fallback of adults probably occurred at some projects during periods of high spill", and that warmer than normal water temperatures July through September "likely caused additional mortalities". The FPC report states these results as <u>probable</u> occurrences, <u>not</u> mortalities that occurred or were measured in 1990.

> *"High spill levels (to benefit downstream passage of smolts) from May through mid-June..."*

The high spill levels occurred because of overgeneration (exceedance of powerhouse capacity) from high natural runoff, not because of flow augmentation to benefit fish.

> *"Passage efficiency was very low in the Snake complex of dams in 1990 compared to 1989 (FPC, 1991)."*

This statement is not supported by the reference to FPC (1991). The FPC report does not state that passage efficiency was low in the Snake complex in 1990 compared to 1989.

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The Fish Passage Center report mentions that the loss of fish between the [Snake complex] projects this season "was higher than normal, based on counts at individual dams." However, it is misleading to rely upon dam counts to assess fish losses due to errors associated with dam counts, fallback, tributary entrance ("turn-off"), harvest, and mainstem spawning.

Page 59, 2.1.5. Downstream Juvenile Passage - General

> *"In 1990, ODFW identified some 56,000 surface water diversions that potentially impact fish populations in Oregon...Less than 1000 (two percent) are presently screened...ODFW ranked the remaining 55,000 thousand* (sic) *unscreened diversions (98 percent) and determined that 3,240 water diversions were significantly impacting fish populations (primarily anadromous salmonids) ... Frankly, we were surprised by the magnitude of unscreened diversions in Oregon (55,000) ... The priority need for some 3,240 fish screens out of a total 55,000 unscreened diversions is a disturbing statistic".*

The authors statements and conclusions regarding the magnitude of screening needs are misleading. Information cited out of context from Nichols (1990) implies that 55,000 water diversions exist in Oregon that need to be screened. In fact, the cited report clearly states that only 3,240 water diversions, representing less than six per cent of all diversions in the state, require fish screening. The remaining diversions are not located where gamefish or nongame threatened or endangered fish species exist.

The authors also state that the majority of the 3,240 water diversions needing screens impact anadromous salmonids. However, the cited report (Nichols 1990) provided no information on species composition from which this conclusion could be substantiated. In fact, a significant percentage of the 3,240 total water diversions identified in the report as needing screens impact non-anadromous salmonids and/or non-game T&E species.

> *"Total anadromous fish losses from unscreened diversions are very large but presently are not estimated. A rough preliminary calculation indicates that losses over the years must be in the <u>billions</u>".* (emphasis added)

The authors state that anadromous fish losses from unscreened diversions are very large but are not estimated. They then reference a calculation that is not identified, explained, or qualified in any way which indicates the loss over the years to be in the <u>billions</u>. This estimate is speculation that is not substantiated.

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> *"Since 1964...and through 1990 a total of 535,000 steelhead smolts were saved* [referencing live box catches on 29 fish screen bypasses in the John Day system]. *If the 300 total screens divert fish at a similar rate to the 29 sampled screens, this would equate to over 5.5 million steelhead smolts saved by the fish screens operated on the John Day River".*

The logic used to estimate 5.5 million steelhead smolts saved by screening ([300/29] * 535,000 = 5,534,482) has a significant problem. The authors assume that any given fish is caught only once in any of the 29 traps, when in fact, any given fish could be trapped many times as it moves downstream past more and more diversions. If each fish was caught twice, their 5.5 million fish estimate would be cut in half. If each fish was caught five times, the estimate would be reduced by 80% to approximately one million fish.

> *"Oregon has relatively strict and straightforward regulations on fish screen protection (ORS 498.248 and ORS 509.615). These statutes require that water diverters provide and maintain screens...at owner expense...the solution does not appear to require additional regulation, but rather enforcement. Funding for enforcement...appears to be the major problem".*

The authors are unaware of substantial statutory changes that occurred in the fish screening laws nearly two years ago. The statutory provisions they cite were debated during the 1991 Oregon Legislative Session and were significantly amended effective July 1, 1991.

House Bill 3457 created a new cost-sharing program for fish screening which includes an implementation schedule for 3100 of the 3240 water diversions identified for screening. The new law specifically prohibits the Department from requiring water diverters to screen their diversions unless it is under the provisions of the new program.

Page 60, 2.1.6. Effectiveness of Fish Screens

> *"ODFW approach velocity criteria are 0.5 fps for fry and 1.0 fps for fingerlings (Pearce and Lee, 1991)."*

The velocity criteria cited by the authors (from a document that is not listed in the references) is outdated and is not currently being applied by ODFW. For the past several years, ODFW has been using approach velocity criteria of 0.4 fps for fry and 0.8 fps for fingerlings.

Page 61, 2.1.7. Downstream Juvenile Passage - Mainstem Columbia-Snake Projects

> *"Maximum hydraulic generating efficiency for vertical axis Kaplan turbines at most Columbia-Snake projects is 90-92 percent."*

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The report should make the distinction that the cited turbine efficiencies (90-92%) are those modeled by manufacturers and that none of the turbines at mainstem dams have been indexed in-situ. Furthermore, it is unknown to what extent turbines are operated at peak efficiency. Monitoring of turbine operations at Corps projects in 1992 indicates that turbines are frequently operated outside of 1% of peak efficiency (operating criteria established by the agencies and tribes) especially during low flow periods.

> *"Today, most researchers use the Schoeneman et at., (1961) 11 percent mortality rate as the best available mortality estimate for typical vertical Kaplan turbines."*

This statement is false. In the Columbia and Snake basins, most researchers use a 15% turbine mortality rate, not the 11% estimated by Schoeneman et al. for McNary Dam. The NPPC used a 15% turbine mortality in System Planning (Integrated System Plan, CBFWA 1990) which is the mid-point of turbine mortality estimates of Columbia River dams (11-20%).

> *"Preliminary screen assessment studies indicate that screening mortalities may be similar to turbine mortality."*

This statement is incorrect and obviously based on a single study, the Bonneville II survival study that showed that mortality of fish passing through the bypass system was higher than fish passing through turbines. The Bonneville II survival study *is* incomplete (adult returns will not be complete until 1995), and results from this study are *not* applicable to other dams due to design problems of the bypass system, location of the bypass outfall in an area of high predator abundance, and high efficiency of turbines (92% compared to 90% or less at other Corps projects).

Page 63, 2.1.8. Modified Habitat Issues

> *"In any event, transportation survival is relatively high (80-90%) in contrast to river migration past and through several water use project."*

This statement should be qualified. It is true that transportation survival of *smolts* is relatively high compared to in-river migrants. However, transportation *survival to adult* compared to in-river migration has been shown to be higher for steelhead at Corps projects but marginally higher for chinook. At mid-Columbia projects, transportation survival of chinook and sockeye to adult has been shown to be *lower* than in-river migration (Carlson et. al. 1989).

> *"Gas supersaturation levels have subsequently decreased, but at higher spill levels they can still cause significant smolt mortalities (NPPC, 1986, FPC, 1991)."*

Although a Fish Passage Center 1991 report is cited as supporting this statement, close review of the FPC report reveals that it is being misinterpreted here. The FPC report

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states, "Because of the high levels of spill that occurred at some projects in 1991, monitoring crews were alerted to note any evidence of 'gas bubble' disease in the fish sampled. There were no reports of injury to fish as a result of gas supersaturation" (page 22, FPC 1991 Annual Report).

Page 65, 2.1.9. Water Flow Rates

> *"Major rivers (native salmonid runs) identified as being seriously impacted by irrigation were the Deschutes, Hood, John Day, McKenzie and Santiam Rivers."*

Anadromous salmonid populations are not seriously impacted by irrigation withdrawals in the McKenzie River basin. A portion of this basin, The Mohawk River, is adversely affected by irrigation withdrawals but this activity only affects resident fish populations (per. comm., Mark Wade, ODFW Biologist, Nov. 17, 1992).

> *"Table 2.1.9-1 summarizes basin water flows, withdrawal rights and instream flow rights data for selected salmonid streams in Oregon."*

This table is not included with the other tables in the back of the report unless it is mislabeled.

> *"Subsequently, McConnaha allocated system survival estimates into individual dam combined turbine and spillway (structural-operational survival, and reservoir survival (non-structural). Individual dam structural survival ranged from 52 to 70 percent for spring chinook and steelhead juveniles (30 to 48 percent mortality per dam)."*

In this paragraph, the authors attempt to summarize McConnaha's table, "Data Base for Reservoir Smolt Survival at Snake-Columbia River Projects" which is presented as Table 2.1.9.-2 in this report. The authors incorrectly identify column b, "Estimated System Dam Survival," in the text as "Individual dam structural survival". Hence, the authors report that individual dam survival ranged from 52 to 70 percent, when in fact, McConnaha's analysis used these estimates to represent combined dam survival for the actual number of dams (5 or 6) present at the time when systems survival data were collected. In his model, McConnaha used estimates of individual dam survival (from 0.89 to 0.93, recognizing considerable spill during the test years) to separate out reservoir and dam survival from the observed system survival data. System dam survival is the product of each assumed individual dam survival.

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Page 66, 2.1.10. Flood Control and Navigation

The following statement is unsubstantiated and misleading:

> *"There are 22 major estuaries in Oregon, plus 17 minor estuaries:... All estuaries were especially critical for native pink and chum salmon, which mostly have disappeared,..."*

There is no evidence that pink salmon were ever native to Oregon estuaries. Chum salmon populations were found primarily in north coastal estuaries with smaller populations occurring in some central and southern estuaries. Only sixteen estuaries in Oregon (including the Columbia River) are believed to have historically contained populations of chum salmon (Chilcote et al. 1992).

Section 2.2. Land Use

Page 70, 2.2.1. General

The authors do not report that the majority of road mileage in Oregon is for the purpose of forest management. Therefore, the negative effects of roads cannot be separated from the other negative effects of logging.

The following passage is contradictory and the second sentence is unsubstantiated because the citation is not listed in the References.

> *"Fine sediments are detrimental to spawning gravel habitats and many millions of salmon and steelhead eggs and alevins have been smothered and subsequently died. However, salmon and steelhead are resilient, and the sediment spawning area impact is not always dramatic (Iwamoto et al., 1978)*

Other citations in this section not listed in the References include: Sidle et al. (1988), Bjornn (1969, 1970), Bjornn et al. (1974), Stober et al. (1982), Duyck (1987), Froehlich (1970), Saltzman (1977), and Burwell (1970).

Roads (pages 73-75 and 177-179):

The report generally appears to be an accurate assessment of the impacts of roads on salmonid habitat, and the relationship of this activity as a factor contributing to the decline of these fish. This section does not identify land management activities responsible for a majority of the road construction affecting salmonid habitat, however. The relative responsibility for road construction may be obtained from a table in this section (page 73) which identifies that 70 percent of Oregon road miles are attributed to an "other" category comprised primarily of forest management roads. In addition, a majority of the literature citations substantiating the impacts of roads were extracted from studies concerning the affects of forest roads. The Department believes that this

discussion should be moved to the "forestry" portion of the report where the results of the studies cited are most applicable.

Solar Radiation-Riparian Vegetation Loss (page 75):

The report states that loss of riparian vegetation can be detrimental to salmonid production due to increased water temperatures in *"...central and eastern Oregon streams..."*, and cites reports indicating that *"[s]unlight and temperature effects are not easily predictable or explainable in western Oregon (NCASI 1987, Hicks et al. 1991)."* While we agree with the statement that loss of riparian vegetation can be detrimental to salmonids, we do not agree with the inference that this problem is limited to central and eastern Oregon. Past scientific studies have noted detrimental increases in stream temperature due to riparian vegetation removal in western Oregon (Brown et al. 1971; Moring 1975a; Moring 1975b; Moring and Lantz 1975; etc.). In addition, the Department was not able to locate information in Hicks et al. (1991) to support the statement that temperature effects are *"not easily predictable or explainable in western Oregon"*. The Department was unable to verify the statement attributed to NCASI (1987) as the referenced study is not documented in the bibliography. These statements appear to be unsubstantiated by the references cited, and are not supported by the majority of research available on this subject.

Page 76, 2.2.2. Agriculture

General Comments

Introductory material consists of questionable assertions concerning historical and contemporary agricultural practices. For example, the statement that "agriculture was the first major step in the evolution of culture and the first alteration of ecosystems" disregards the prior emergence of language, clothing, and religion, and the ecological consequences of cooperative hunting and the use of fire.

Historical (pages 77-78)

> *"In 1970, private acreage for crops in Oregon had risen to 5.3 million acres...[s]ome 1.7 million acres were irrigated."*

According to the most recent data available from the U.S. Department of Commerce (1987 Census of Agriculture 1:37 Oregon State and County Data), there were 2.8 million acres of cropland in Oregon, 1.6 million of which were irrigated, not 5.3 million acres of cropland with 1.7 million acres irrigated as suggested (citing 1970 data).

The total for the first column of the untitled table at the bottom (million acres dryland) is 4.6, not 3.6.

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Irrigation (pages 78-81)

The totals for the columns in the Table titled Oregon River Basin runoff characteristics (cfs) are 105,000 (mean annual runoff), 22,500 (mean summer runoff), and 5730 (low summer runoff) respectively, not 107,000, 21,000, and 6,000 as indicated.

Nonpoint Source Pollution (pages 80-81 and 159-160):

The authors provide an adequate assessment of the distribution and impacts of nonpoint source pollution (NPS), but they imply that agriculture is the only land management activity responsible for these problems. Nonpoint source pollution is common to many land use activities, but agriculture appears to be solely implicated because: (1) this discussion is presented only in the agriculture section, and (2) by the statement that *"agricultural land use predominates the monitored problem areas."* It should be clarified that the referenced ODEQ report was prepared to guide the development of an NPS database and NPS control plans, and was not designed as a "...fault-finding or finger-pointing exercise" (ODEQ 1988). Further, the statement that agriculture *"predominates the monitored problem areas"* is not a conclusion of, nor appears to be substantiated by the ODEQ report. Assigning the relative importance of land management activities based upon the location of "monitoring areas" is an invalid approach that does not recognize that upstream activities can affect water quality in downstream reaches.

The ODEQ report (ODEQ 1988) included a description of land use activities potentially contributing to NPS problems by citing the "land uses most commonly cited in connection with" the NPS problems for each basin. This qualitative information is summarized in Table 1. For consistency with the OFIC report subject, six basins were excluded because they do not contain anadromous salmonids. Forestry was referenced by the respondents as often as agriculture and grazing in identifying land use activities potentially contributing to the NPS problems. Forest management was also identified as a potential contributor in all basins where anadromous salmonid populations exist except the Umatilla.

The ODEQ also presented a version of this information in a subsequent document that reported the number of miles of stream affected by NPS pollution in each basin of the state, and the suspected sources of this pollution (ODEQ 1990). This information is reproduced in Table 2 (basins without anadromous salmonids were again excluded from the comparison for consistency with the OFIC report subject). This information suggests that forest management activities represent a considerable source of NPS pollution, and that the number of stream miles potentially affected by forestry exceed the estimates for all other individual activities. The authors incomplete presentation of the ODEQ reports resulted in potentially erroneous conclusions.

In describing the relative distribution of NPS problems the authors cited ODEQ (1988) in reporting that:

> *"Hood River Basin appeared most affected (84 percent of assessed miles had moderate or severe water quality impacts), and the Rogue River Basin appeared least affected (44 percent of assessed miles had water quality problems)."*

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Forestry was the "most commonly cited land use activity" (Table 1), and was suspected of affecting the majority of stream miles (Table 2) in the Hood River Basin ("most affected") while agriculture was considered less important. In addition, the Rogue River Basin ("least affected") was only one of two coastal basins where forestry was not one of the "most commonly cited" land use activities potentially contributing to NPS problems, and was the only coastal system where forestry was not the dominant source of stream miles affected by NPS pollution (Table 2).

Table 1. The "most commonly cited" land use activities attributed to NPS problems identified in the ODEQ NPS Report (ODEQ 1988). This analysis is qualitative and is only compiled to highlight problems with statements within the OFIC report. Basins without anadromous salmonids were excluded for consistency with the subject discussed in the OFIC report.

	Land Use Activities	
Basin	Most Commonly Cited	Others Cited
Coastal		
North Coast	FOR, REC	IR-AG, NI-AG, GR
Mid-Coast	FOR, GR, NI-AG	
Umpqua	FOR	GR, RNG
South Coast	IR-AG, NI-AG	FOR, GR
Rogue River	IR-AG	FOR
Interior		
Willamette R.	FOR	IR-AG, NI-AG, URB
Sandy River	FOR, REC	
Hood River	FOR	AG, REC
Deschutes River	GR	FOR, IR-AG, REC
John Day	GR, IR-AG, NI-AG, FOR, REC	
Umatilla	IR-AG, NI-AG, GR	
Walla Walla		
Grande Ronde	GR, FOR	

IR-AG=irrigated agriculture, NI-AG=nonirrigated agriculture
FOR=forestry, GR=grazing REC=recreation URB=urban
RNG=rangeland management

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Table 2. Summary of river miles, by basin, affected by nonpoint source pollution, and the suspected causes. This table was reproduced from Table 3.2-4 of ODEQ (1990). The table was modified to only include basins supporting anadromous salmonid populations.

Table 3.2-4: Suspected Nonpoint Sources of Water Quality Problems in Rivers where Beneficial Uses Are Not Fully Supported — Summary by Basin of River Miles Affected by Each Source (1988 Assessment)

RIVER MILES IMPACTED BY MORE THAN ONE SOURCE ARE COUNTED SEPARATELY FOR EACH SOURCE

	Nonpoint Source								Natural	Other
	Agriculture	Range	Forestry	Storm Water Combined Sewers	Construction	Transport	Mining	Recreation		
stU ·ia	475	315	615	135	185	325	295	425	480	0
	350	195	545	10	85	20	90	295	115	0
	365	415	820	110	30	375	185	135	270	0
·it	430	180	625	40	15	75	135	15	215	0
	615	250	545	225	270	165	300	215	637	0
	720	495	585	680	485	400	420	1,255	480	5
	5	5	115	5	10	0	0	120	55	0
	120	100	155	10	0	40	0	100	40	0
	705	970	520	210	190	65	110	675	205	0
	1,120	1,315	1,035	5	0	0	125	685	985	0
a	620	670	140	70	50	40	45	85	75	0
nde	390	805	680	55	60	340	135	540	70	5
	5,915	5,715	6,380	1,555	1,380	1,845	1,840	4,545	3,627	10

e information in this table was based on DEQ's nonpoint source assessment which was completed in 1988. The assessment is a data base which contains data (based on actual sampling, including the results of DEQ's ambient monitoring) and evaluated data (based on a combination of data, observation, and l judgment). The evaluated data were largely provided by other agencies and have not yet been verified by DEQ. The mileage numbers should therefore be estimates. Updates of the assessment are planned. In this assessment, most of the information received was for major first-order streams where problems no problems were reported for a particular stream segment, that segment was grouped with the *"fully supported"* segments. Streams with *"moderate"* water blems were classified as *"partially supported"*. Streams with *"severe"* water quality problems were classified as *"not supported"*.

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Erosion (pages 82 and 160):

The authors state that:

> *"A storm of equal intensity will cause at least two times the erosion on agricultural lands as on managed forest lands (Sedell and Beschta, 1991)."*

Review of the cited document failed to substantiate this statement. Sedell and Beschta (1991) cited one study by Hickin (1984) which reported that:

> "...riverbanks that are well bound by roots offer far greater resistance to lateral erosion than relatively unvegetated banks of rivers of western Canada. For similar hydraulic conditions and bank characteristics, a river migrating through a cleared or cultivated floodplain would erode at nearly twice the rate of one reworking a naturally forested floodplain." (Sedell and Beschta 1991) [emphasis added].

The statement appears to be a misinterpretation of this study. The study by Hickin (1984), as summarized by Sedell and Beschta, compares relative erosion rates between floodplains with vegetation removed and naturally forested floodplains. The statement from Sedell and Beschta (1991) makes no distinction between agricultural or forest management vegetation removal: the study refers to "cleared or cultivated" floodplains where "cleared" implies that vegetation was removed. In addition, erosion rates on cleared land were compared to naturally forested floodplains: the assumption that naturally forested floodplains are synonymous to "managed forest lands" is not substantiated by Sedell and Beschta (1991).

The discussion of floodplain functions presented in Sedell and Beschta (1991), including studies by Hickin (1984) and Li and Shen (1973), substantiated the value of floodplain habitats. These studies highlighted the need for the protection of natural vegetation along floodplains to reduce erosion and sediment transport, protect the natural ecological functions of these areas, and to provide necessary fish and wildlife habitat. Sedell and Beschta (1991) referenced a study by Li and Shen (1973) in reporting: "an exponential increase in relative sediment transport rate as cylinders were removed (i.e. as trees were harvested) from floodplain forests. This relationship highlighted the need to retain trees on forested floodplains to reduce sediment transport of floodwaters."

Grazing, (pages 84-85)

The authors present no discussion of the regional nature of the problem, distinctions between public and private range conditions, problems with bank stability, groundwater, water quality, water temperature, etc. Literature citations are inadequate considering the great amount of agency and academic interest in this topic.

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General (pages 84-85)

This section is an odd mixture of beaver lore and anecdotes concerning settlement and channelization. The fact that mining has contributed to current fish habitat problems is acknowledged in a single sentence, lumping it with agriculture and mining.

The authors cite research by McIntosh, Sedell and Clarke (1992) documenting historical stream degradation and the loss of pool habitat on the Grande Ronde River. These changes were appropriately attributed to the cumulative effects of land use practices over a fifty year time interval. However, the authors appear to imply that agriculture and mining are the primary causes, and that forestry impacts were restricted to activities prior to 1941:

> *"The biggest stream habitat problem today is in the agricultural lands below the forest..."*
>
> *"Land use practices responsible for the degradation...are historical and include agriculture and historical mining and forestry (pre-1941)."*

These statements, and the fact that the discussion is only present in the "agriculture" section, seem to imply that other land uses in the basin are a minor component of the habitat problems. The observation that the loss of the most productive habitat occurred where farms and ranches are located today (in the mid-section reaches) implies that agriculture may be responsible, and neglects that sediment impacts are transported downstream from upper portions of watersheds. Also, the statement limiting forestry impacts to "pre-1941" is inconsistent with the study results which measured habitat changes occurring after 1941 (1941-1990). The authors also repeat these statements in the summary section (page 163).

Similar research assessing the cumulative changes to stream habitat over time has been conducted by Jim Sedell (US Forest Service, PNW Research Station). Hicks et al. (1991) cite the results of a study (Sedell, unpublished) which showed a 70 percent loss of pool habitat over 50 years following large-scale timber harvest and salvage of downed timber in the Breitenbush River, Oregon. This information was not presented even though Hicks et al. (1991) was cited several times in this report.

Summary (pages 85-86)

The authors conclude that agricultural practices are the *"...dominant land use practices...of concern for wild salmonid[s]."* There is no mention in any section of problems associated with diked pastures or transportation systems that support farms and ranches.

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Page 86, 2.2.3. Forestry

General Comments

This section provides an incomplete review of the available scientific information concerning the relationship between forest management and salmonid habitat productivity. The report does not adequately present existing information on several subjects (large woody debris and water temperature), attributes forestry-related studies and impacts to other land management activities (roads and riparian vegetation removal) and does not present the results of several important long-term studies of the affects of forest management on salmonid habitat and salmonid productivity.

The importance of large woody debris for salmonid habitat, and the relationship that riparian conifer harvest contributes to the shortage of this material is not adequately presented. For a comprehensive literature review, the report should include information contained within: Naiman et al. 1992; Bisson et al. 1992; Bisson et al. 1987; Bilby and Ward 1989; Bilby 1981; Robison and Beschta 1990; Bustard and Narver 1975; McMahon and Hartman 1989; Heifetz et al. 1986; Nickelson et al. 1992; Andrus et al. 1988; Ursitti 1990; and many others.

The relationship between riparian vegetation removal, water temperature and the productivity of salmonids is not presented in adequate detail. For a comprehensive literature review, the report should include the results of such studies as: Holtby 1988; Beschta et al. 1987; Brown et al. 1971; Duston et al. 1991; Li et al. (in process); Ringler and Hall 1975; and many others.

The results from long-term studies of forest management and salmonid habitat are not presented in the report. For example, the results from studies such as the Alsea Watershed Study (Moring 1975a, 1975b; Moring and Lantz 1975) and the Carnation Creek Study (Hartman and Scrivener 1990; Holtby 1988) should be included in the report for the document to be comprehensive.

Woody Debris Removal (page 88):

The report presents a significant discussion of past debris removal activities by fisheries agencies, but does not investigate the role of riparian conifer harvest on the long-term supply of large woody debris. The current shortage of this material is primarily attributed by the authors to debris removal activities, but research exists that also discusses the relevance of these shortages to timber harvest. In addition, the report does not acknowledge that typical debris removal projects involved log jams consisting of hundreds of logs that totally obliterated sections of streams.

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Fine Sediments (pages 90 and 172):

The authors make several statements concerning the effects of fine sediments on salmonid production which are inaccurate, and are not supported by the literature cited. The specific statements were attributed to Hicks et al. (1991) and are as follows:

> *"Fine sediments reduced spawning success but may have locally increased primary and secondary productivity. Locally, increases in food production for juvenile and salmonids* (sic) *may have increased nursery carrying capacity."*
>
> *"Sediments* [from logging related surface erosion, mass wasting, roads, scarification and slash burning] *generally reduced spawning success and rearing capacity but may have increased rearing capacity locally."*
>
> *"Invertebrate production may have been locally stimulated..."* [referring to logging related increases in fine sediments] (page 172).

Information reported by Hicks et al. (1991) is directly contrary to the statements contained within this report. Hicks et al. (1991) state that: "in addition to directly affecting salmonid survival, fine sediment in deposits or in suspension can reduce primary production and invertebrate abundance and can thus affect the availability of food within a stream (Cordone and Kelley 1961; Lloyd et al. 1987)." In addition, Table 14.1 from Hicks et al. (1991), which is accurately reproduced in the OFIC report (pp 170-172), specifically attributes increased fine sediments to "reduced food abundance" and "loss of winter hiding space". Nowhere in the text or tables of Hicks et al. (1991) could the Department document information to support the OFIC report authors' statements.

Natural Sediment Losses in Undisturbed Forests (page 92):

For comparative purposes, the table presented on page 92 would be improved if the data were converted from "tons per square mile" to "tons per acre". Most references to erosion and sedimentation in this report are based on the latter standard of reference. A conversion of this data (below) allows comparison to text references (BLM 1981; BLM 1983) of forest related sedimentation: road related sedimentation presented for these references appears to be 20X to 300X greater than the maximum PNW Average Range for sediment loss in undisturbed watersheds.

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Miscellaneous Natural Sediment Losses in Undisturbed Forests (tons per *acre* per year)*	
Lowest Range	0.003-0.031
PNW Average Range	0.23-0.55
Three Alsea Watersheds Average	0.49
Castle Creek, N. California	1.46
N. Calif. Coast Marine Soils	3.13

Reproduced from the OFIC report; no verification of original data accuracy*

Chemical Use, Agriculture and Forestry (pages 93, 164 and 174):

The information presented in the table on page 93 is misleading, and does not appear to be reflective of the actual total use of chemicals by the forest industry. As noted by footnote "(b)" of the table, the chemical use attributed to "forestry" only includes chemicals applied by the U.S. Forest Service on National Forest lands and is, therefore, a vast underestimate of the total use of chemicals by the forest industry. The estimates for agricultural chemical use are extracted from an EPA report which presumably estimates total agricultural use within the entire nation. The authors of the original report from which this data is extracted (Norris et al. 1991) specifically note that: "these figures underestimate the total use of pesticides in forestry because they do not include pesticides applied by other U.S. agencies or by state or private forest management groups." The "ratio comparison" prepared by the authors of the OFIC report is not valid since it is based on incomplete data, and should not be included within the report.

Several other statements in this section of the report are also questionable:

> *"These ratios* [referring to the previously discussed table] *could be applied to the land use acres for agriculture (5.3 million acres crops, 22.7 million acres range) versus timberland (21.9 million acres).*

Application of the chemical use ratio estimates to the agricultural and forest land acreages would result in an inaccurate estimate of relative chemical use.

> *"[Pesticide] application is often by aerial spray, except a large portion of herbicide is now hand sprayed..."* (emphasis added)

This statement is not substantiated by any literature citations, and is contrary to current forest management trends. The authors may be referring to U.S. Forest Service pesticide use being restricted to hand spray applications due to a nationwide ban on aerial application of these chemicals (Norris et al. 1991). Attributing this trend to all forest lands is not indicative of current land management practices.

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Regulations and Practices (pages 95 and 169):

The authors cite several provisions of the Oregon Forest Practices Act incorrectly:

> *"Buffers...were...maintained on state Class I streams to protect soils and provide 75 percent of shade."*
>
> *"...and streamside vegetation were to be in near natural condition...and provide for 75 percent post operation shade cover."* (emphasis added)
>
> *"The 75 percent stream shade rule was retained with the addition of a 50 percent overstory canopy rule...Trees may be cut in the RMA, if the actual riparian zone meets the 75 percent stream shade and 50 percent overstory canopy rules."* (emphasis added)
>
> *"The 75 percent post operation shading rule was retained and a 50 percent canopy rule was added...Trees could be cut in the RMA if the 75 percent post operation stream shading and 50 percent canopy requirements were met. Otherwise, timber in the RMA was protected to meet the shade and canopy rules."* (emphasis added)

These rules are improperly interpreted and do not reflect the current management restrictions placed on timber harvest activities within Oregon riparian management areas (RMA). The correct language of these rules is as follows:

OAR 629-24-546 (3) (a) Maintain an average of 75 percent of the preoperation shade over the aquatic area along Class I waters.

OAR 629-24-546 (3) (b) Retain at least 50 percent of the preoperation tree canopy in the riparian area along Class I waters.

Timber harvest activities are currently allowed to reduce existing shade and overstory vegetation to 75 percent and 50 percent, respectively, of preoperation conditions. These regulations are not currently based upon postoperation conditions as the report states. The authors also imply that timber harvest activities are restricted if preoperation conditions are less than 75 percent shaded and 50 percent overstory canopy closure; these restrictions are not a current requirement of the Oregon Forest Practices Act. For example, recent monitoring conducted by the Oregon Department of Forestry indicates that, on the average, shading on streams within the ODF Northwest Region was reduced from 83 percent preoperation levels to 61 percent following logging (ODF, Water Temperature document from technical workshops related to SB1125).

This section should be rewritten to reflect the actual legal requirements of the Oregon Forest Practices Act.

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Page 96, 2.2.4. Municipal - Industrial

This section discusses point source pollution discharges by municipal and industrial entities, but presents tabular information that is very misleading. A table listing the number of stream miles "adversely affected" by such parameters as low dissolved oxygen, bacteria, turbidity, elevated stream temperatures, etc. is presented in a manner that implies that municipal and industrial sources are the cause of this pollution. However, the data in this table actually reflects an assessment of statewide nonpoint pollution problems from a multitude of land use activities. The report cited for this information (ODEQ 1990) indicates that municipal and industrial sources are a minor component of the pollution problems, and that the majority of stream miles affected are attributed to forestry and agricultural practices: a figure in the ODEQ report identifies the relative sources of pollution as forestry (17.4%), agriculture (17.4%), municipal (2.4%), industrial (0.8%), mining (5.2%), etc.

> *"...some 1,062 miles of river reaches that do not support beneficial uses by point source municipal pollution."*
>
> *"...some 386 miles of river reaches are listed as impaired by point source industrial pollution..."*

In the second statement, the actual number of miles affected by point source municipal pollution is reported as 368 miles by ODEQ (1990).

If the analysis is restricted to basins containing anadromous salmonids (the focus of the OFIC report), the correct estimates of stream reaches impacted by point source pollution would be 1,036 miles for municipal pollution, and 342 miles for industrial pollution.

Additionally, for comparative purposes it should be noted that the estimated river reaches impacted by nonpoint sources of pollution are 6,380 miles for forestry activities, and 5,915 miles for agriculture activities (excluding basins without anadromous salmonids).

Page 98, 2.2.5. Mining

This discussion of historical mining in Oregon provides very little information concerning the effects of mining activities on salmonid habitat or salmonid productivity. Additional literature review should be completed to assess the potential effects of these activities on salmonids.

The authors cite ODEQ (1990) in stating that:

> *"...some 2,280 miles of streams potentially adversely affected by non-point* (sic) *source mining problems."*

The estimate of miles affected is correct if all basins in Oregon are considered. However, if the analysis is restricted to basins with anadromous salmonids the actual estimate of stream reaches affected by mining is 1,840 miles.

> *"This* [gravel extraction] *has probably contributed to the lack of recovery of pink and chum salmon stocks in coastal rivers."*

As discussed previously, pink salmon are not indigenous to Oregon, therefore, it is unlikely that mining has prevented the "lack of recovery" of these fish within this state.

Section 2.3. Environmental Phenomena

Page 100, 2.3.1. Natural Phenomena

The following passage is inaccurate and misleading:

> *Every two to seven years, a reversal in tropical Pacific wind and ocean currents generally occurs. This phenomena, termed El Nino,* (sic) *brings warm surface waters and easterly winds to the West coast of the Americas. Upwelling and subsequently primary productivity, is suppressed..."*

Whereas El Niños are common in South America, contrary to the impression presented, El Niños of a magnitude to bring warm water to the coast of Oregon have been rare. Only 4 times in the past 50 years has this happened: 1941, 1957-58, 1982-83, and 1992.

Page 101, 2.3.2. Predation and Competition

Introduction, Natural Predation (pages 101-102)

These two paragraphs are one of the few places in the report where predation is accurately presented as a natural, important, or positive influence in biological systems:

> *"...salmonids are also an integral component of a complex, natural ecosystem."*
>
> *"...they* [salmonids] *represent a food source to natural predators..."*
>
> *"Salmonids have always been exposed to predation. They coevolved with their predators in the natural environment without either completely avoiding or succumbing to them."*

However, these accurate descriptions of the significance of adaptive evolution, long-standing trophic interactions, and energy transfer immediately give way to the overriding premise that, due to various population and environmental changes, current predator-prey relationships in the marine environment have been "reshaped". The

report proceeds with the premise that such predation is no longer considered natural, but instead is a "human-influenced biological interaction" that has contributed significantly to declines and/or lack of recovery of Oregon wild salmonids. These conclusions are not supported by the information or analyses presented in the report.

Freshwater System Alterations (pages 102-103):

The following statements are questionable:

> *"The large numbers of hatchery juveniles may buffer predation on wild fish."*

The large numbers of hatchery juveniles may, conversely, stimulate predation via functional response (Vigg 1988).

> *"Predator populations may be increasing simply because there is an ever increasing supply of prey."*

Predator numbers are probably not regulated or affected by salmonids because these fish are a small fraction of the diet ration (Poe et al. 1991).

Fish predation (pages 103-105):

> *"These predator populations would otherwise decline if forced to rely primarily on ever diminishing populations of wild native juvenile salmonids."*

Predators don't rely on wild native juvenile salmonids, instead use resident feeds (invertebrates, sculpins, suckers, etc.) (Poe et al. 1991).

> *"These results are similar to the findings of Uremovich et al., (1980), who estimated that northern squawfish may have eaten 3.8 million juvenile salmonids in the forebay of Bonneville Dam in a five-month period in 1980 (Table 1.7-1)."*

Estimates by Uremovich et al. (1980) are greatly inflated because of sampling design problems.

> *"Although no estimates of predation were given, Thompson and Tufts (1967) reported that northern squawfish predation was significant on juvenile sockeye salmon in Lake Wenatchee, Washington."*

Incomplete...see Brown and Moyle (1981).

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> *"Studies by Poe et al. (1991) between 1983 and 1986 revealed that from April to August salmonids comprised (by weight) 67 percent of the diet of northern squawfish, 33 percent of channel catfish, 14 percent of walleye, and four percent of smallmouth bass."*

These results are skewed by disproportionate sampling in the boat-restricted zone (Poe et al. 1991).

> *"J. Petersen et al. (1990) observed that salmonids constituted from 73 to 99 percent (mean 91 percent) of the northern squawfish diet in July of 1988."*

In the immediate vicinity of the dam which is not representative of the squawfish population.

> *"However, if northern squawfish prefer dead and injured over healthy prey, then these fish may be more of a scavenger than an active predator."*

Clearly an active predator (Rieman et al. 1991):

1. Most loss occurs far from dams where fish are likely to be healthy.
2. Laboratory tests not corroborated in field where different conditions make it difficult to discern prey condition (by predators).

Bird Predation (Pages 105-106)

This section provides some information concerning bird predation on salmonids, however, it does not provide the information necessary to evaluate the relative contribution of this factor to the decline of Oregon's salmonid resources. While it is true that bird predation is a natural component of the freshwater and marine ecosystems, no information was presented to suggest that the loss of salmonids to this factor is increased above natural historic levels.

Specific comments on the information presented are as follows:

> *"Ruggerone (1986) estimated that ring-billed gulls... consumed two percent of the salmon and steelhead trout passing Wanapum Dam..."*

Ring-billed gulls, as many gull species, are opportunistic feeders and are likely to exploit prey as the opportunity exists. The predation rates observed by Ruggerone (1986) may not be applicable to the overall gull population, however, as the information was collected in the vicinity of a dam. Salmonids at this location were

likely more susceptible to predation due to passage related injuries or disorientation. It is also likely that the gulls in this study were scavenging dead smolts below the facility.

> *"Wood (1987) noted that mergansers may limit salmon production in nursery areas in British Columbia. He estimated that young merganser ducklings can consume almost one half pound of chinook salmon fry per day. Thus, a brood of ten ducklings could consume between four and five pounds of fish daily during the summer rearing period."*

The authors reference for Wood (1987) does not correspond to the information presented. Wood actually presented two studies in the referenced journal; the information presented appears to be derived from Part II, not Part I as cited.

Wood (1987a) concluded that merganser predation on seaward migrating salmonids was not likely to affect salmonid populations:

> "Juvenile salmon are more vulnerable to predation for a period of days, or at most weeks, during their downstream migration. A predatory species must be very abundant to inflict appreciable mortality ...the overall mortality rate due to mergansers was depensatory-mergansers were simply swamped by the output from spawning channels and hatcheries."
>
> "The mortality rate due to mergansers is very unlikely to have exceeded 8% for any particular stock during downstream migration.."
>
> "Probably no single species of avian predator is capable of inflicting compensatory mortality on juvenile salmonids during their seaward migration...it follows that predation by all fish eating birds, acting in concert must also be depensatory and that salmon populations cannot be regulated by avian predation during their seaward migration."

The actual study the authors cite (Wood, 1987b), discussed merganser predation on stream-resident populations of salmonids. A major conclusion of this study was not reported:

> "It is not clear whether mortality due to merganser broods has any effect on the eventual size of smolt migrations in Vancouver Island streams. Because merganser ducklings kill salmonid fry during summer months, there is ample opportunity...for compensation to occur if overwinter survival is further limited by food or habitat..."

An analysis of the applicability of this study to Oregon streams should consider whether the abundance of mergansers is similar to that observed in the British Columbia study area.

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> *"White (1938) found an inverse relationship between stream flow and percent of brook trout in the diet of kingfishers ... evidently the kingfisher experienced increased feeding efficiency in slower moving waters caused by stream diversions."*

Did White (1938) cite the cause of stream flow changes as water diversions, or did the study measure predation rates under natural fluctuations of stream flow?

> *"Studies (Mathews, 1983) have shown that the common murre..."*

> *"Thus, the estimated 40,000 birds that occur off the Oregon coast each spring could account for the loss of several million smolts for each month that their presence coincides with the arrival of salmonid smolts."*

The referenced study is not included in bibliography, so we were unable to verify the accuracy of the cited information. In addition, we question whether the estimated consumption of salmonids by common murres was reported by Mathews, or if this calculation was completed by the OFIC report authors. A listing of the assumptions inherent to this calculation should be provided so that the validity of the estimate can be evaluated.

> *"McNeil et al. (1991) demonstrated that survival of hatchery-reared coho salmon could be markedly improved by transporting them in net-pens...avoiding bird and fish predation in nearshore waters. It is likely that wild salmon smolts would be susceptible to the same type of predation."*

While we agree that wild smolts would be susceptible to the same type of predation (birds and fish), the amount of predation on hatchery fish is likely to be markedly greater due to releases of large numbers of smolts within a short time period. These hatchery release strategies may attract predators due to the concentration of prey species (salmonids). The implication that wild smolt survival would be markedly increased in the absence of this predation (as reportedly occurred at the private hatchery) is unsubstantiated.

Marine Mammal Predation (Pages 106-112)

The report notes that protective legislation has resulted in increases in some marine mammal populations in the Pacific Northwest, and suggests that:

> *"...these recent increases in marine mammal numbers are causing increased predation rates on salmonids."*

No reference or scientific substantiation is provided for this statement. While there are reports documenting increases in some mammal populations over time, there are no

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comparable studies that examine changes in "predation rates on salmonids". The authors conclusion appears to be unsubstantiated.

Harbor Seals (page 107-108)

The report refers several times to Chapman et al. (1991) as a reference source for harbor seal abundance estimates. This reference is a PNUCC report on Snake River chinook, and is only an indirect reference for harbor seal abundance or population increases in the Columbia River area, Washington, or Oregon. The primary source of this information is ODFW, WDW, and NMFS (contract reports, administrative reports, and unpublished data). Some of the abundance estimates presented in this discussion are incorrect.

The report references Olesiuk et al. (1990) in discussions of harbor seal predation on salmonids, but some of the information and conclusions from this study are omitted. For example, Olesuik et al. (1990) reported that the dominant seal prey items in British Columbia were hake and herring; 75% of the total diet combined. Salmonids made up just four percent of the diet and represented less than three percent of the mean annual escapement for the entire Strait of Georgia. This level of predation loss does not seem to be a highly significant contribution to salmon mortality, even though "predator" numbers apparently increased from 10,000 in 1970 to over 80,000 in 1988.

Using the information from Olesiuk et al. (1990), and the same questionable methods of calculation found in this section, it could be hypothesized that if it took 80,000 seals in B.C. to consume 866,800 pounds of salmon, then the 10,000 seals in Oregon would take only one-eighth of that amount or just 108,350 pounds (12,312 salmon). This estimate represents only three percent of the 1990 Oregon salmon landings (as presented in the report) not 58 percent as suggested (page 108), or just six percent by weight, not 64 percent.

> *"Harvey calculated that salmon represented almost 11 percent of the total biomass that harbor seals consumed."*

The report referred to several Oregon studies that reported that salmonids can comprise between one and 12 percent of seal diets. The report then used a relatively high value of 11 percent (Harvey 1988) to complete statewide calculations of salmonid consumption. Not surprisingly, this analysis resulted in a greater estimate than would have been derived by using a median value of salmonid consumption from the various studies.

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"Harvey estimated that harbor seals consumed 1.3 million pounds of salmon in Oregon in 1980..."

"Because the Oregon harbor seal population has increased to 10,000 animals since 1980, it would now consume approximately 1.8 million pounds of salmon..."

The report uses an estimate from Harvey (1988) that seals consumed 1.3 million pounds of salmonids in Oregon in 1980 to conclude that this represents 30 percent of the 1980 landings. This conclusion does not recognize that the majority of the salmonids Harvey reported to have been consumed by seals were steelhead, and not "feeder" chinook or coho as stated in the report. The authors then use the (incorrect) figure of 10,000 seals in Oregon and extrapolate to estimate that 1.8 million pounds of salmon were consumed by seals in 1990. The report then incorrectly uses this data (which includes Harvey's steelhead estimate) to compare these predation loss estimates to ocean commercial troll landings of salmon.

The report uses incorrect figures and comparisons to report increases in pounds of salmon consumed by seals statewide and in the Columbia River between 1980 and 1990. These calculations do not constitute valid scientific methodology, and the conclusions drawn are not supported by the data.

"Numerically, salmon may represent less than one percent of the harbor seals diet..."

The report acknowledges that, based on Harvey (1988), salmon numerically comprise less than one percent of the seals diet in Oregon. However, the report suggests that salmon (by weight) can comprise at least 10 percent of the "diet requirement". This statement is misleading: if less than one percent of the fish eaten by seals is salmon, then, less than one percent of the fish eaten is salmon. Rephrasing the statement does not change the reality. Seals, nor any other marine mammal, require salmon in their diet. What is required is a certain biomass of food, usually fish, of which salmon is a relatively unimportant component in the overall diet.

Other scientific data concerning harbor seal food habits were not presented in the report, including data collected by ODFW and WDW in the Columbia River. In 1986, 1987, and 1988 the gastrointestinal tracts of 84 harbor seals collected during winter salmon and steelhead run periods were examined for food habits analysis. Eulachon was the most important prey item, by frequency and by weight, occurring in 100% of the seal stomachs. Longfin smelt and lamprey occurred in 14.3% and 9.5% of the samples respectively. Five other species of fish were consumed by these seals. No salmon or steelhead had been consumed by any of the 84 harbor seals in this sample. This was the largest collection of seal stomachs for food habits analysis that has been completed in Oregon to date.

This study of the Columbia River suggests that harbor seal predation on salmon and steelhead is minimal; however, it would not be valid to extrapolate these results to the entire Oregon coast for all seasons of the year to imply that harbor seals do not consume salmonids.

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Sea Lions (pages 108-110)

> *"In their studies in the early 1980s, Beach (1982) reported maximum counts of 150 to 200 California sea lions in the vicinity of the Oregon coast."*

Beach (1982) is not listed in the bibliography. Beach et al. (1985) would be the appropriate reference, and it is listed in the bibliography. However, Beach et al. (1985) only reported California sea lion numbers in the Columbia River area, not "in the vicinity of the Oregon coast". The authors erroneously imply that large increases in sea lion numbers were documented in Oregon through the 1980's. Neither the data in Beach et al. (1985) nor the information presented in this report support this conclusion. ODFW and WDW have unpublished data that suggests that numbers of California sea lions in Oregon and Washington during the winter have increased along with growing breeding populations in California. However, these data series are incomplete and are not highly useful in demonstrating trends in California sea lion numbers in Oregon.

> *"The northern sea lion has a North American population of about 200,000 animals with most in the Gulf of Alaska (Olesiuk and Bigg, 1988)."*

The reference used for Steller sea lion population status in North America, and the estimates of abundance presented are not current. More recent information is available from the National Marine Fisheries Service, Seattle.

> *"A maximum of 350 to 400 northern sea lions were recorded off the coast of Oregon in 1982 (Beach et al. 1982)."*

Beach et al. (1982) is not referenced in the bibliography. Again, this reference is apparently used incorrectly by referring to numbers of sea lions reported in the Columbia River area as being "recorded off the coast of Oregon".

> *"...a resident population of from 200 to 400 northern sea lions in Oregon...(Robin Brown, ODFW personal communications, 4 March 1992)."*

In this statement the meaning of "resident" is unclear. The abundance estimates are inaccurate. This is an important point because these estimates and the "residency" status are used directly in the calculations of salmonid consumption by this species. Manipulation of these estimates and the use of the term residency could significantly

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alter the outcome of such calculations. In reality, the number of Steller sea lions that occur in Oregon throughout the year is probably greater than the estimate of 300 used in Table 2.2.7-3, however, the actual number of sea lions present in any area at any time are nearly impossible to estimate with much accuracy. Therefore, any consumption estimates based on such numbers are also likely to be inaccurate.

"The sex ratio of the northern sea lions in Oregon is assumed to be 1:1."

No reference is provided to support this statement. A 1:1 sex ratio may be accurate for newborn pups, but not necessarily for adults. This is an important consideration since greater prey consumption rates for larger males are weighted evenly with those of smaller females in the calculations within this report. In reality, large males probably make up a relatively small portion of the total population when compared to females, juveniles of both sexes, and pups combined. It is inappropriate to use average estimated consumption rates for adult males and adult females, and apply them to the total population (which includes hundreds of juveniles and pups) with equal weight.

"The diet of all wintering sea lions off southern Vancouver Island...(Olesiuk and Bigg, 1998)...equals one percent of British Columbia's total annual commercial landings of salmon."

The report briefly cites this conclusion of Olesiuk and Bigg (1988) and then appears to ignore the implications of this conclusion. Assuming that British Columbia fisheries are managed properly, the total commercial landings should not be expected to have a significant negative impact on salmon populations. Therefore, the additional one percent of the harvest amount taken by sea lions should have a minimal, if not insignificant, affect on the commercial harvest, and an even smaller impact on total salmonid populations in British Columbia. If this is the case in British Columbia, it is difficult to believe that sea lions could play such a significant role in the reduction of salmonid populations in Oregon (as this report suggests).

"Seasonal aggregations of California sea lions near the mouth of the Columbia River are <u>believed</u> to feed on large concentrations of smelt (Eulachon sp.) (Beach et al. 1985)." (emphasis added)

The report implies that there is some doubt regarding the importance of pinniped predation on smelt. Existing information supports that both seals and sea lions feed heavily on smelt. The large smelt run during winter months is believed to attract seals and sea lions into the Columbia River. Smelt is the most frequently consumed and important prey of seals and sea lions in the Columbia River at that time of the year (Beach et al. 1985; ODFW, WDW unpublished data). While some seals and sea lions do remove salmon from gillnets, free-swimming salmon constitutes a minor dietary component relative to Eulachon.

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"However, almost 13 percent of the stomach contents of California sea lions taken in the Columbia River area in 1982 was salmon;...(Beach et al. 1985)"

The report does not acknowledge that these samples were collected in an area where, and most often when, gillnet fisheries for salmon where taking place. There is no question that sea lions (and seals) prey on salmon in gillnets in this area. The resulting analysis of sea lion diets from such collections cannot be applied to sea lion numbers statewide to estimate salmon consumption over a broad geographic area because of the influence of this fishery on the diet of these species. The report notes that Jameson and Kenyon (1977) and Roffe and Mate (1985) showed that salmon made up a small part of sea lion diets and that predation had negligible impacts on Rogue River salmonid populations. It would also be invalid to use these studies to imply that sea lion predation has no affect on salmon numbers anywhere in the Northwest.

"Based on the above data, it would seem reasonable to assume that salmon could comprise...ocean commercial fishery in 1990."

The calculations and consumption estimates presented in the report are not arrived at by defensible scientific methods. Because of the numerous assumptions and variables involved, the results presented are highly questionable and probably very inaccurate. For example, it is inappropriate to use predation estimates from a single study in British Columbia and broadly apply them to pinnipeds in completely different geographic areas where behavioral, biological, environmental and other factors affecting both predator and prey populations (including relative abundances) may be very different. Site specific studies are required to make valid estimates of this type.

The calculations of salmonid loss to marine mammal predation are also affected by assumptions concerning salmonid (prey) availability. It cannot be assumed that salmon are available to every predator every day of the year (or every day that a pinniped is in Oregon waters). Nor can it be assumed that pinnipeds would selectively consume salmon when other more abundant, more easily caught and consumed prey are available (particularly for harbor seals). Many of the calculations in this report are based on the assumption that salmon are available to marine mammals 365 days of the year: estimated predation losses, therefore, likely over-estimate actual losses greatly.

Other Marine Mammals (pages 110-111)

This discussion mentions that several other marine mammal species have been known to consume salmonids at some time, but provides no information of the relevance of this fact to the decline of Oregon's wild salmonids. Of some 34 marine mammal species that occur in the northeastern Pacific, 10 have been known to consume salmon at some time (Fiscus 1980). In Oregon, less than five of these species have salmonids in their diets with any frequency. Three of those are the pinnipeds discussed previously. In general, marine mammals as a group are thought to have negligible effects on free-swimming salmon in the open ocean (Fiscus 1980).

Killer whales are known to consume seals and sea lions, but the report only briefly mentions this fact. Certain groups of Orca are known to specialize on pinniped as

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prey. Whereas the whales that feed mostly on salmonids tend to be resident of the northern Puget Sound and Vancouver Island area, these pinniped-eating whales are more migratory. It is suspected that the Orca observed regularly off the Oregon coast, and seasonally in coastal embayments, are part of these migratory, pinniped-eating groups. Consumption of pinnipeds by Orca has been observed at several Oregon locations in recent years.

Marine Mammal-Fisheries Interactions (page 111)

> *"Thus, seal damage at this rate for the 1990 commercial catch...would have accounted for the loss of between 4,200 and 11,200 fish from the fishery..."*

The rates of pinniped damage to gillnet caught salmon are misused in this analysis. The majority of fish in the studies referred to, while damaged (sometimes very slightly) were still salable, were sold by the gillnetters and thus were not "lost", and, therefore, cannot be compared to total commercial catches for the Columbia River. For example, less than one per cent of all fish caught in the Columbia River 1991 winter fishery were unsalable due to pinniped damage (Herczeg et al. 1991; ODFW unpublished data). This information contradicts the "three to eight percent" values that were broadly applied to the total annual Columbia River salmon catches.

> *"They* [Chapman et al. 1991] *further concluded that a total of 8,100 fish had died as a result of these bites in 1990..."*

The report does not state how it was determined that 8,100 fish "died" as a result of "seal marks". The information that was presented provides the reader no rationale for assessing the validity of this conclusion. However, the authors incorporate this estimate into their analyses without further discussion. This data, while attributed to issues related to Columbia River dams, also appears later in the report text and tables as "Oregon salmonid loss to seal bites".

Summary (pages 111-112)

This section repeats the estimates of marine mammal predation and compares these estimates to fishery harvest statistics. These calculations are based upon simple mathematics, erroneous and misinterpreted data, and the erroneous assumptions identified in the previous portion of this review. The statistical significance of these estimates is likely to be very low, and, therefore, should not be compared to fishery harvest statistics that possess a much higher degree of accuracy.

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"Because these marine mammal populations have been recently increasing...it is reasonable to assume that their consumption of salmonids has increased at a similar rate."

It is not "reasonable", as stated in the report, to simply assume that the consumption of salmonids by marine mammals has increased at a rate similar to estimated increases in some of their population numbers. It is not scientifically valid to assume that there are simple, direct linkages between rates of population growth and rates of selected prey species consumption: predator-prey relationships are much more complex than this simple assumption portrays.

"...it follows, then, that marine mammal predation has contributed to the recent decline in Oregon salmonid abundance."

Contrary to this statement, it does not follow from the "data" presented in the report that marine mammal predation has contributed to the recent decline in Oregon salmonid abundance. This statement appears to be a conclusion of the authors that is not substantiated by the scientific information presented in the report.

"Seal and sea lion populations have been increasing in Oregon while salmonid fishery resources have been declining."

This statement is incorrect. The report does not present scientific information to suggest that a direct causal relationship exists between these two trends. While some seal and sea lion populations have increased, others have not; and while some salmonid populations have declined, others have not. It is impossible to prove that a direct causal relationship exists given the evidence provided in this report. The complexity of salmonid declines has been linked to a variety of possible factors including freshwater habitat degradation, harvest, water diversion, dam construction, and other human activities. Given the multitude of possible factors, it is wrong to suggest that a direct causal relationship exists between these declines and marine mammal abundance.

"Presently, these marine mammals are consuming a higher proportion of salmonids than they did in the recent past."

This conclusion is not supported by the scientific information presented in the report.

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> *"...it is possible, though speculative, that if Oregon Indians in the past kept seal and sea lion populations low, then the present rate of marine mammal predation on Oregon salmonids may be at historically high levels."* (emphasis added)

As the authors' themselves state, it is speculation to suggest that Oregon Indians kept seal and sea lion numbers low. It could equally be true, and may be more likely, that pinniped numbers were higher before white men inhabited the west coast and began to hunt, harvest pinnipeds (including bounty harvest), harvest fish (pinniped prey) and alter freshwater fish habitat.

Competition (page 115)

Seals and Sea Lions (pages 115-116)

This section of the report contains questionable calculations of prey consumption by pinnipeds; this time presenting pinnipeds as competitors with salmonids for herring. These questionable calculations suggest that by eating herring, Oregon pinnipeds are responsible for the loss of more salmonids than sportsmen caught in all Oregon coastal streams in 1990.

The report continues to develop questionable estimates of salmonid losses because of dietary overlap between salmonids and other fish, pinnipeds, and birds. Questionable multipliers and energy conversion rates are applied to arrive at ambiguous and likely erroneous results.

> *"The point of this discussion is not to determine the degree of competition that salmonids experience in the ocean, but to draw attention to its existence and scope."*

The discussion does not provide the level of scientific accuracy necessary to evaluate the "scope" of these competitive interactions. These interactions are natural biological processes that have occurred for millions of years. No information is presented to document that these interactions have increased, or that these interactions are playing a significant role in the decline of Oregon's salmonids.

> *"And finally, the recent increases in pinniped populations suggest a commensurate increase in competition with salmonids to a level that did not exist in the recent past. This increase in competition could be contributing to the recent decline in the abundance of Oregon salmonids."*

As was discussed previously, the report does not provide any scientific evidence to conclude that marine mammal abundance has increased above natural historic levels, or

presented scientific studies that document increases in competition between salmonids and marine mammals. This conclusion is solely speculation.

American Shad (pages 117-119):

Competition for Food

> *"One obvious reason the American shad population has been increasing in the Columbia River system, while salmonids have been declining, is the absence of an intense fishery for the American shad as exists for salmonids."*

The increase in American shad numbers is unrelated to the fishery on them. If anything, the fishery on American shad has expanded as their numbers have increased.

> *"As stated previously in this chapter, the food base of the lower Columbia River has changed from a macrodetritus to a microdetritus source."*

What are the references on this?

> *"Even if only one percent of the eggs produced viable young that migrated to the Columbia River estuary (the actual percentage is probably much higher),..."*

The actual percentage is probably lower. Survival of eggs to postlarvae probably a small fraction of a percentage.

> *"Juvenile American shad are a potential competitor with the juveniles of any pink...remaining in the system..."*

As stated earlier, pink salmon are not indigenous to Oregon streams (Emmett et. al. 1991). The inference that competition with shad is causing a "decline" of these species in Oregon is erroneous.

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> *"And even though the shad is primarily a plankton feeder, the overlap of benthic prey in its diet and in the diets of other juvenile salmonids, such as chinook salmon, coho salmon, and steelhead trout, provides ample evidence that competition is occurring,..."*

This statement is not true. No conclusion can be drawn from overlap (it is unknown if food is limiting).

The discussion of competitive interactions between American shad and anadromous salmonid juveniles is largely a hypothesis that the authors do not substantiate with scientific research. The major weakness in this argument is that the authors fail to document the extent of spatial and temporal overlap in estuary rearing habitat between these species, or demonstrate that food availability is limiting juvenile salmonid production in the Columbia estuary. The authors also fail to note that juvenile shad are a prey source of juvenile salmonids in rivers and estuaries (Emmett et al. 1991). An alternate hypothesis of this fact could conclude that the increased abundance of juvenile shad should have caused increased salmonid production because of an increased food supply (assuming that food supply is limiting salmonid production).

Reduced Population Size

Why is this subheading presented in the American Shad section?

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RECOMMENDATIONS

Management (page 123)

"Institute marine mammal (seal and sea lion) management"

This is a vague and poorly thought out recommendation. While many would agree that limited actions to reduce pinniped predation on certain depressed fish stocks at localized sites would be desirable, the broader implications of the recommendation are not supported by the data. There is no evidence presented in the OFIC report to support the premise that population control or reduction of marine mammals would directly result in any real or measurable increases in Oregon salmonid populations.

SUMMARY AND CONCLUSIONS

Many of the previous comments concerning the presentation and interpretation of literature citations are pertinent to this section of the report as much of the report is repeated. For brevity, the Department has attempted to avoid repeating our comments in this portion of the review, and refer the reader to previous discussions.

Management Factors (p. 128-139)

Page 128, Historical Catch

The following statement is inaccurate and unsubstantiated:

> *Landings of chinook salmon in southern Oregon ports doubled from a mean of 56,000 fish from 1971 to 1978, to a 1979 high of 107,000 fish. This was directly related to reduced spawner escapements of 47 percent from 1978 to 1979 (Rankel, 1980)"*

The second half of this statement is not supported by escapement records for the two largest southern Oregon populations, the Rogue and Umpqua rivers (*See* Nicholas and Hankin 1988). The source for this statement (Rankel 1980) is not listed in the References.

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Page 131, Escapement

The following statements are inaccurate:

Page 131 and Table S-1:

> *"Overfishing is evident when one compares the survival rates to escapement for coastal coho salmon from the OPI ocean fishery from 1970 through 1983, which averaged 11 percent, to the 1984 through 1989 survival rates, which averaged 39 percent"*

The survival rates to escapement presented for coastal coho salmon here are incorrect. It appears that the authors mistakenly included catch, but not escapement, of Columbia River coho when they calculated these values. Based on the ODFW OCN database, average survival to escapement for 1970-83 was 25%, not 11%, and for 1984-89 was 58%, not 39% (text) or 26% (Table S-1?). Marked hatchery groups at Fall Creek Hatchery averaged 20% for the years 1978-83 and 38% for the years 1984-89 whereas marked groups from Salmon River Hatchery averaged 28.5% for the years 1979-83 and 48.5% for the years 1984-89.

Page 132, and Figure S-3:

> *"From the 1950s to the present, there is a significant downward trend in spawner escapements of coastal and Columbia River coho stocks"*

The description of the trend in coho salmon spawners on the Oregon Coast and in the Columbia River is inaccurate. The declines began in the mid to late 1960s not the 1950s as claimed (*See* the ODFW Coho Plan Figures II C-5 & C-6).

Page 133 and Figures S-4 and S-5:

> *"...in each year that the escapement goal was not met, catch exceeded the escapement goal by a factor of 2 to 5.*

In years when escapement goals were not met, catch of OCN coho salmon actually exceeded their escapement goal by factors of 0.54 to 1.37, not 2 to 5 as is stated. See the review of "Section 1.2.4. Spawning Escapement and Return to Rivers".

It is not clear how Figure S-4 was derived. This figure is not present in PFMC (1991) as stated, and it is not possible that coastal coho were 2.5 million out of a 4 million OPI in 1976. The scale of Figure S-4 is about half what is needed, resulting in the impression that the difference between catch and total production is smaller than it really is.

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> *"Further, actual escapements year-to year are directly correlated with percent survival from production to escapement for the same years (Figure S-5)*

This statement is false. Figure S-5 has the same errors in survival to escapement as discussed above for page 131 and Table S-1. A statistical test of the correct data demonstrates no relationship between the percent escapement from the fisheries and escapement.

Harvest Rates (page 136):

> *"Forty to 60 percent harvest of wild salmonids is generally optimal for maximum sustainable yield,..."*

The source for this statement is not stated. However, MSY harvest rates for OCN coho salmon have been estimated to be 61.8-72.8% (PFMC 1992, Table 1 and ODFW Coho Plan) not 40-60%.

> *Actual ocean and river harvests for both chinook and coho salmon have ranged from roughly 70 to 90 percent..."*

Except for one year, every year since adoption of the Coho Plan, harvest rates for coastal coho have been below 60%.

Environmental Factors (p. 139-182)

Page 139, Human-Influenced Biological Interactions

Predation (pages 139-141)

Predation and competition between naturally occurring species of fish and wildlife, including salmonids, are certainly "natural phenomena" but the report presents these relationships under the loosely defined category of *"human-influenced biological interactions"*.

No scientific evidence was presented to support the contention that "human actions" have significantly changed overall marine mammal predation pressures on salmonids. Since there have been no measures of this "pressure" 100 years ago, 50 years ago, or even 10 years ago, it is not valid to suggest that such general predator-prey relationships and interactions in the majority of the habitat have changed. It is true that for specific fish stocks that have been depressed for reasons related to various human activities, and at sites where dams, ladders, water diversions or other human structures have restricted free movement of salmonids, predation from pinnipeds can have significant impacts (e.g. Ballard Locks, Seattle). However, there is no information presented in the report that supports the premise that human actions have altered the

balance of the pinniped-salmon predator-prey relationship that has occurred in the open ocean for millions of years.

> *"Populations* (marine mammals) *have steadily increased in Pacific Northwest waters and these increased populations are now causing significant predation losses on anadromous salmonids."*

This statement is not supported by the scientific information or analyses presented in the report. This statement appears to be an unsubstantiated conclusion of the authors.

The scientifically questionable calculations of salmonid consumption by marine mammals are repeated within this section of the report. All the previous comments on the methodology employed, the assumptions inherent to these calculations, and the conclusions drawn from these analyses apply to this discussion also.

Food Resources-Competition (p. 144-145)

> *"Assuming an eight percent efficiency of energy transfer, this could represent 850,000 pounds of salmon."*

This assumes 100% of herring not eaten by mammals is converted into salmon biomass. This is unlikely because salmon not limited by herring diet.

Page 158, Agriculture

General Comments

This section is largely a repeat of the information presented on pages 76 through 86, and includes many of the same improper conclusions that were discussed previously. The only new information concerns reference to the Tillamook Bay "Erosion Sediment Study" which is discussed in both the agriculture and forestry sections of the summary. The Department has limited the discussion of this study to specific issues in the "agriculture" section, with a thorough analysis of the OFIC authors interpretation in the "forestry" summary review.

Tillamook Bay Erosion Study (pages 160-162):

[Please refer to the "forestry" section for a thorough review of this study]

The authors discussion of this study (USDA-SCS, 1978) is incomplete. In addition, Table S-7 (page 160) appears inaccurate and does not correspond to information presented in the SCS report. A compilation and analysis of the information presented in the SCS report is presented in Table 3:

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Table 3. Estimates of annual erosion and sediment runoff into streams from agricultural lands in the Tillamook Bay Basin. Data derived from "Tillamook Bay Drainage Basin Erosion and Sediment Study, Oregon--Main Report" (USDA-SCS, 1978).

Subbasin	Acres	Total Tons	Erosion Tons/Acre	Total Tons	Sediment Tons/Acre	Sediment Runoff/Erosion Ratio
Miami	1,217	1431	1.18	1173	0.96	0.81
Kilchis	3,369	1948	0.58	1427	0.42	0.72
Wilson	4,124	2607	0.63	2018	0.49	0.78
Trask	10,697	4375	0.41	2752	0.26	0.63
Tillamook	9,375	3020	0.32	1441	0.15	0.47
BASIN	28,780	13,381	0.46	8812	0.31	0.67

This information is pertinent to the accuracy of text references:

> *"Total erosion averaged 0.6 tons/acre/year, 0.35 to 1.6 tons/acre/year range. Related stream sediment loading rates averaged 0.4 tons/acre/year."*

The Departments' calculations indicate that total erosion is estimated at 0.46 tons/acre/year, with a range of 0.32 to 1.18 tons/acre/year, and with sediment loading of 0.31 tons/acre/year.

More important, however, are the conclusions of the authors concerning the impacts of agriculture on sedimentation processes in Tillamook Bay:

> *"Stream bank and channel erosion from cattle are serious sedimentation problems in the lower floodplain reaches of streams in the Tillamook Bay Basin (USDA, SCS, 1978). Ninety percent of stream sediments originating in these predominantly pasture lands come from stream bank and channel erosion sources."*

> *"Cattle move into channel bottoms...Banks and stream channel edges are broken down and direct sedimentation occurs. Subsequently in storm flows, stream bottom scour and constant bed gravel occur (ibid)."*

This statement implies that stream bank erosion and the resultant sediment discharges are strictly a result of stream side cattle use. This statement ignores text from the SCS report which directly cautioned readers from making this assumption: "forest lands and croplands have been separated in the study for inventory and analysis. The two areas are not independent, however; upstream problems can either amplify or reduce downstream problems. The total sediment in the system is the crucial problem." The SCS study documented significant sediment loads originating from forest lands (51,603 tons/year), and that a high proportion (8 to 66 percent range) of this material was

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fluvial bedload (large material). This material could have been accelerating the erosional processes in the downstream agricultural reach.

The report also attributes the cattle-related sedimentation and stream bank erosion to the loss of pink and chum salmon populations:

> *"This could help explain the loss of native pink and chum salmon populations in the lower reaches of coastal streams."* (emphasis added)

While we agree that sedimentation could have a role in the decline of Oregon's chum salmon populations, this statement is inaccurate for pink salmon in Oregon. Pink salmon are found in oceanic and coastal areas north of about 40° N latitude, and are not indigenous and only rarely observed in coastal streams of Oregon. The distributional range of this of this species is from approximately Skagit Bay, Washington, northward (Emmett et. al. 1991).

Chemical Use, Agriculture and Forestry (page 164):

The authors again present information (in a table on page 164) comparing the "ratios" of agriculture and forestry chemical use, only this time it is presented in the "agriculture" section. As discussed previously, this information greatly underestimates the use of chemicals on forest lands because it only includes chemicals applied on US Forest Service lands. The Department refers the reader to our previous discussion of this information.

Page 165, Forestry

General Comments

There is no discussion of the effects of water temperature increases due to forest practices, and very little discussion of the effects of timber harvest on the instream supply of large woody debris. Significant amounts of scientific information exist for these topics.

Again, there is no mention of the results of the Alsea Watershed Study (Moring 1975a, 1975b; Moring and Lantz 1975) or the Carnation Creek Study (Hartman and Scrivener 1990; Holtby 1988) in this discussion of forestry.

> *"Logging slash...decreases dissolved oxygen demand..."*

Logging slash increases dissolved oxygen demand (not decreases, as stated).

The first paragraph on page 174 discusses sedimentation but give no specifics as to the relationships between forest practices and sedimentation, or sedimentation and salmonid

survival. The Alsea Watershed Study (Moring 1975a) documented increased sediment loading of 11-175% associated with logging and 54-205% associated with logging road building. Phillips et al.(1975) documented 80% reduction in survival of alevins with 50% fine sediment.

Tillamook Bay Erosion Study (pages 173-174):

The authors use a portion of the information contained in the SCS report (USDA-SCS 1978) to imply that the agricultural industry is the primary contributor to sediment problems in the Tillamook Bay basin:

> *"Stream sediments from agriculture were twice that from forests in the Tillamook Bay drainage basin on a unit area basis (Table S-10)."*
>
> *"A significant difference between agricultural and forest stream sediment contribution was the relative amount of eroded materials that entered streams. In agriculture, 70 percent of eroded sediments become fluvial sediments; in forestry, however, only 20 percent become fluvial sediments."*

These statements are based upon an incomplete discussion of the study, and ignore the contribution that sediments (particularly bedload material) from upstream areas can have on the acceleration of stream bank erosion in downstream reaches. The majority of the fluvial sediment originating from the agricultural lands was due to stream bank erosion (approximately 88 percent). The SCS report cautioned that: "forest lands and croplands have been separated in the study for inventory and analysis. The two areas are not independent, however; upstream problems can either amplify or reduce downstream problems." The SCS report further noted that terrestrial sources of sediment "...serves as an abrasive agent to increase the effectiveness of the flowing water as an erosive agent." The authors failure to recognize that upstream activities on forest lands may have affected stream bank erosion on agricultural lands results in conclusions that are not supported by the SCS study.

An alternate analysis of the relative impact of each land use activity could be achieved by eliminating stream bank erosion from the total sediment estimates (Table 4):

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Table 4. Estimates of sediment discharge into streams of the Tillamook Bay Basin resulting from upland erosion (stream bank erosion not included in this analysis). Data extracted from the SCS report "Tillamook Bay Drainage Basin Erosion and Sediment Study, Oregon--Main Report" (USDA-SCS, 1978).

	Non-Stream Sediment					
	Forest Land			Agriculture		
Subbasin	Acres	Tons	Tons/Acre	Acres	Tons	Tons/Acre
Miami	24,290	1281	0.053	1217	59	0.048
Kilchis	43,320	3003	0.069	3369	126	0.037
Wilson	121,110	5536	0.046	4124	144	0.035
Trask	101,940	10981	0.108	10697	397	0.037
Tillamook	33,570	4169	0.124	9375	370	0.039
BASIN	324,230	24,970	0.077	28,780	1,096	0.038

The SCS report noted that forestry is a significant contributor to the sediment problems in Tillamook Bay (USDA-SCS, 1978):

> "The total sediment in the system is the crucial problem."
>
> "Erosion and sediment delivery rates on forest lands still make significant contributions to the problems of the basin. The mean annual gross erosion amounts to 286,245 tons. The mean annual fluvial [into the streams] sediment load is 51,602.6 tons from forest lands. These are 95.6 percent and 85.1 percent, respectfully, of the basin totals."

The OFIC report failed to acknowledge these conclusions by the original authors.

Regulations (page 175):

> *"In 1972, forest practice rules began to slow down salmonid habitat and water quality degradation caused by forestry operations, and gradual improvement continued through 1986"*

This statement implies that logging is no longer a major cause of salmonid habitat degradation because of forest practices rules. On the contrary, data collected recently by ODFW Research and Development suggests that the productive potential for coho salmon of Deer Creek (Alsea Watershed Study stream - patch cut) has declined by 60% since 1966, whereas, the productive potential of Flynn Creek (uncut) has remained the same.

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Agriculture (page 176):

Again, according to the most recent data available from the U.S. Department of Commerce (1987 Census of Agriculture 1:37 Oregon State and County Data), there were 17.8 million acres of farmland in Oregon, not 28 million as stated here. Perhaps the difference here may be attributed to government grazing land leased on a per-head basis that is excluded from the Department of Commerce total, or perhaps the reference is to 2.8 million acres of harvested cropland. Who knows?

Page 180, Natural Phenomena

Climate and Catastrophes (P. 180-181):

> *"Storms of equal intensity will cause twice the erosion on agricultural lands as on forested lands (Sedell and Beschta 1991)."*

As discussed previously, the source cited by the authors does not substantiate this statement. The contention that the research presented by Sedell and Beschta (1991) supports a differentiation between erosion rates on agricultural and managed forest lands appears to be a misinterpretation or misrepresentation of the scientific study by Hickin (1984).

Ocean Productivity (P. 181-182):

There is no discussion of the effects of temperature in non-El Niño years (*See* Nickelson 1986).

> *"...as ocean conditions changed with the development of the 1982-1983 El Nino."*

The most recent series of years with poor ocean conditions actually began in 1976, upwelling was weak and a warming trend was apparent, well before the 1982-83 El Niño (McLain 1984; Nickelson 1986).

> *"There is a suggestion that native coastal coho salmon had more of a north-migrating tendency in the past than hatchery coho salmon, and were less affected by El Nino..."*

The statement is not supported by the data presented in Fig.1.1-8, attributed to McKernan et al. (1950). The effects of the 1941 El Niño are evident on the 1942 catch in all rivers.

Natural Predation (p. 182):

Lack of stream complexity resulting from logging activities, especially log transport, probably contributes greatly to predation in freshwater.

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The following statement is not supported by data:

"It is likely that wild smolts are susceptible to murre predation."

A study of murre predation in Coos Bay showed that, except for the period during the summer when private hatcheries were releasing very large numbers of smolts, murres did not prey upon salmon (Daniel Varoujean, Coos Bay, Oregon, personnel communication, August 1992 - reports were produced).

REVIEW OF TABLES

This section provides a review of a portion of the tables presented in the OFIC-sponsored report. The majority of the tables we reviewed presented fishery harvest statistics.

Page 200, Table 1.1-1. Life History of Native Oregon Salmonids

This table provides a fair representation of life histories of 10 species/runs. Five of the 50 life history cells in the table are in slight error. The stock status column denotes "declining" for all 10 species/runs: this is subjective and the table does not show how the determinations were made.

The primary source for this table is the ODFW/WDF "Status Report, Columbia River Fish Runs and Fisheries, 1960-90." Yet the source citation says ODFW 1991a, which in the references is shown to be the Clackamas Subbasin Plan. This erroneous citation is rampant throughout the report.

Page 201, Table 1.1-2. Historical Status of Major Runs of Columbia River Salmonids.

This table is a synopsis of nine of the same 10 species/runs in Table 1.1-1. It shows eight or nine to be "decreasing" with fall chinook "Increasing." Several errors are present in the "Notes" column. The primary source is ODFW and WDF (1991) which is again erroneously cited.

Page 202, Table 1.1-3. Columbia River Commercial Landings Chinook, Coho, Sockeye, Chum, and Steelhead since 1886.

The primary source of 1866-1959 data is an NPPC "Compilation" report. The data for 1960-90 is from ODFW and WDF (1991). The data presented for 1938-59 agrees with ODFW data for chum salmon only. Data for 1960-90 contains three typos. Data for 1866-1937 was not verified.

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Page 205, Table 1.1-4. Estimated Historical and Current Run Size of Columbia River Salmonids.

This table purportedly reports historical and current run sizes of Columbia salmonids. However, the data presented in this table does not provide a valid comparison of trends. The data presented as "run sizes" for 1983, 1986, and 1990 only includes Columbia returns. The data for 1977 reports the total Columbia production (ocean catch and Columbia return). The data for the 1890's again only reports Columbia returns (this data set was developed prior to meaningful ocean salmon fisheries). These types of comparisons are not valid as presented.

The following minor problems were also identified: (1) the Gunsolus citation misspells his name, and (2) the source for the 1983, 1986, and 1990 data is ODFW and WDF (1991) which is erroneously cited.

Page, 206, Table 1.1-5. Brief Review of Historical Commercial Catch by Species of Columbia River Salmonids in Pounds and Numbers, 1866-1990.

This table compares current year (1990) catches to low years, peak years, and initial year (1866). Data for current and low years is from ODFW and WDF (1991) (erroneously cited) and contains one error, several omissions, and several addition errors. Data for peak and initial years were not investigated. The "Source" reference lists ODFW 1971, which is not in the list of References, but which is probably FCO and WDF (1971): "Status Report-Columbia River Fish Runs and Commercial Fisheries, 1938-70".

Page 207, Table 1.1-6. Incomplete Estimate of Sport Catches of Chinook Salmon from Tillamook Bay and Tributaries and Six Coastal Rivers, 1947-60.

Data is this table was not investigated. The source is listed as Nichols and Hankin, 1989. This listing is not in the references. The references section does list a Nicholas and Haskin, 1989. Most probably the authors were referring to Nicholas and Hankin, 1988.

Page 208, Table 1.1-7. Oregon Salmonid and Steelhead Trout Annual Tags Issued and Estimated Sport Salmon and Steelhead Trout Catch, 1978-90.

This table lists number tags issued and salmon and steelhead catch by year from a report prepared by ODFW Fish Division, December 1991.

There are several rounding errors in the table and the source is listed as ODFW, 1991a, which in previous tables has been actually referencing ODFW and WDF (1991). This report does not carry this data. The authors corrected an error in the Fish Division report.

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Page 209, Table 1.1-8. Oregon Commercial Salmon and Steelhead Trout Catch 1978-1990.

This table lists Columbia River (from ODFW and WDF 1991, erroneously cited) and ocean (PFMC 1991) salmon catch, and treaty Indian steelhead landings (from ODFW and WDF 1991, erroneously cited). There are three errors in the table.

Page 210, Table 1.1-9. Columbia River Adult Salmonids Catch Numbers.

This table lists the catch by species-run for commercial (lower river gill-net), sport (primarily lower Columbia), and treaty Indian (commercial and/or ceremonial and subsistence). The commercial landings are erroneous for five out of 17 entries. The sport landings listed are for lower Columbia main stem except fall chinook, which are basin-wide catches. Sport landings are erroneous for six out of 17 entries. Treaty landings are ceremonial and subsistence only for spring chinook and sockeye, which is correct as these were the only fisheries available to treaty fishers in 1990 yet the remaining landings are commercial only (ceremonial and subsistence is not included). One of the 17 entries is in error. The primary source is ODFW and WDF (1991) (erroneously cited).

Page 211, Table 1.1-10. Current Status of Major Runs of Columbia River Salmonids.

This table displays "Notes" relative to the current status of 15 species-runs of Columbia salmonids. This table is deficient in that several runs of various species were not displayed and only mentioned in the "Notes" section.

There are eight numerical errors and another error in the "Notes."

There are estimates of the number of wild spawning coho in 1980, and in the present, that are not found in either of the sources listed.

The primary source for this table is ODFW and WDF (1991) which is erroneously cited.

Page 213, Table 1.1-11. Columbia River Commercial Landings of Salmon and Steelhead Below Bonneville Dam, 1960-90.

This table is an accurate reproduction of Table 12 from ODFW and WDF (1991) though it is erroneously cited.

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Page 214, Table 1.1-12. Number of Columbia River Gil (sic) Net Licenses Issued, 1960-90.

Except for the title, this table is an accurate reproduction of Table 10 from ODFW and WDF (1991) though it is erroneously cited.

Page 215, Table 1.1-13. Days Open to Commercial Main Stem Salmon Fishing Below Bonneville Dam, 1960-90.

This table is an accurate reproduction of Table 11 from ODFW and WDF (1991) though it is erroneously cited.

Page 216, Table 1.1-14. Columbia River Commercial Landings of Salmon and Steelhead Above Bonneville Dam, 1960-90.

This table is an accurate reproduction of Table 15 from ODFW and WDF (1991) though it is erroneously cited.

Page 217, Table 1.1-15. Days Open to Commercial Salmon Fishing Above Bonneville Dam, 1968-90.

This table is an accurate reproduction of Table 14 from ODFW and WDF (1991) though it is erroneously cited.

Page 218, Table 1.1-16. Combined Oregon and Washington Angling Catch on the Lower Columbia River.

This table is a reproduction of Table 3 from ODFW's "Lower Columbia River and Buoy 10 Recreational Fisheries" annual report for 1990 (Melcher and King, 1991). This table contains 14 errors when the authors mis-rounded exact numbers in ODFW's report to the nearest hundred.

Page 219, Table 1.1-17. Combined Oregon and Washington Salmonid Angling Effect (sic) on the Columbia River, 1960-90.

This table attempts to show the salmon catch per angler trip on the lower Columbia River. The authors use the word "Effect" in the title as a description of catch rate. This is a new term to us. The table is incorrect in that the authors have taken the total annual catch of salmonids and divided it by the annual totals for angler trips that not only included salmonid trip totals, but those for shad and sturgeon as well. In most recent years the annual totals for sturgeon angler trips has exceeded that for salmonids. This leads to more than a 50% under-estimate of "effect." Finally, the authors have used an incorrect annual salmonid catch total for 1979.

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Page 220, Table 1.1-18. Sport Catch, in Numbers, of Salmon and Steelhead Trout in the Oregon Tributaries of the Columbia River, 1978-90.

This table lists catch estimates from ODFW's angler-returned salmon/steelhead catch record. There are four errors.

Page 221, Table 1.1-19. Buoy 10 Sport Effort and Catch of Pacific Salmon, 1982-90.

The data in this table is from Melcher and King (1991). There is one error.

Page 222, Table 1.1-20. Current Status of Major Runs of Oregon Coastal River Salmonids.

This table attempts to describe the status of Oregon's coastal salmon populations using three categories; decreasing, no trend, and improving. The status for several populations is labeled "unknown". Sources are Nicholas and Hankin (1989) (in list of References this source is Nicholas and Haskin, 1989); ODFW 1982 (Coho Plan); and ODFW 1985 (not listed in References).

The following deficiencies were identified:

The table's footnote states the table is laid out as in Nicholas and Hankin (1989) yet the authors did not follow that format.

The status for Yachats chinook is not decreasing but is unknown.

The "notes" for Trask and Tillamook chinook are wrong.

In the coho section reference is made to 36 stocks, perhaps this actually refers to the 36 chinook stocks previously described.

The coho section is extremely deficient in that all stocks are lumped together and given one status description--"decreasing."

It is unknown to the reader which data in the table can be attributed to the three sources listed at table's end.

Finally, the table title is misleading in that it says "....Status of Major Runs....." The runs described in this table number from 100 to 100,000 fish.

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Page 225, Table 1.1-21. Sport catch of Salmon and Steelhead Trout in Oregon Coastal Streams, 1978-90.

This table lists catch estimates from ODFW's angler-returned salmon/steelhead catch record. There are four errors.

Page 226, Table 1.1-22. Oregon Ocean Salmon Commercial Troll Landings and Effort, 1991 (sic)-90.

This table is derived from PFMC's "Review of 1990 Ocean Salmon Fisheries." There are two errors. Additionally, the pink salmon catches for the 1970's uses two 5-year averages when the actual pink landings by year were easily available on an adjacent table in the PFMC report. Note the title says "1991-90." The actual years are 1971-90.

Page 227, Table 1.1-23. Oregon Ocean Salmon Sport Catch and Effort, 1971-90.

This table is derived from PFMC's 1990 report. There are no errors. As in the troll table, pink salmon catches for the 1970's uses two 5-year averages when the actual pink catches by year were easily available on an adjacent table in the PFMC report. Authors used a 5-year average for 1976-80 angler trips and divided it into actual year by year catches to derive annual salmon/angler trip. The salmon/angler trip for these years are erroneous and likely not even similar to actual. These statistics should not have been shown.

Page 228, Table 1.1-24. Indirect Causes of Mortality to Commercial and Sport Fisheries in Oregon for 1990.

This table shows percentages and numbers of mortalities. The table headings do not say mortalities of what. The title suggests mortalities to fisheries. Assuming it is fish, three categories of indirect causes are listed. The authors refer the reader to the text "for explanation."

1) Ocean Troll shaker loss - text explanation:

> *"...an annual shaker morality* (sic) *value of between 30 and 40 percent seems appropriate for Oregon."*

The table lists 1990 harvest as 582,000. This figure is the total sport and commercial catch of chinook and coho in Oregon ocean waters. Using the author's 30-40% that "seems appropriate" results in mortality numbers of 174,400 to 232,500 salmon in Oregon's ocean fisheries in 1990. PFMC estimates the 1990 commercial troll coho loss at 54,300, 21% of the total catch (loss plus landed) of 259,200. PFMC accounts for troll hooking mortality in their catch-quota decision-making. There are no estimates for commercial troll chinook or sport fishery losses in the PFMC process nor does there seem to be a need to do this as losses from these fisheries are regarded as low.

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2) Columbia River gill-net dropout loss - text explanation:

> *"...it seems reasonable to assume an annual dropout mortality rate of between 4 and 8 percent for the Columbia River commercial net fishery."*

The text explanation for these estimates were based on the Klamath River tribal fishery and the Puget Sound gill-net fishery.

The table lists harvest as 257,000. This figure is the total commercial landings in the Columbia from Zones 1-5 gill-net, Youngs Bay terminal, and tribal set-net fishery above Bonneville Dam of all species including Indian-sold steelhead and includes all landings by Washington fishermen. There have been no studies on gillnet dropout in the Columbia. Gillnet dropout is believed by ODFW to be low and the mortality rate for dropped-out fish varies considerably by species, by gillnet type, and by time of year.

3) In-river sport loss - text explanation:

> *"...it would be reasonable to assume a minimum loss rate of between three and nine percent for the in-river sport fisheries of Oregon..."*

These estimates were based on steelhead studies conducted in British Columbia. Applying this study to Oregon's catch and release program for wild winter steelhead, ODFW reportedly assumes a loss of 3% using barbless hooks and 9% using barbed hooks, and assumes losses are higher for summer steelhead because of warm water and low flow.

The table lists harvest as 241,000. This includes the sport catch in Oregon's coastal streams, Oregon's tributaries of the Columbia River, the Oregon and Washington catch in the lower Columbia, and Oregon and Washington catch in the Buoy 10 fishery. The majority of the catch in the Buoy 10 fishery is made by Washington anglers. This facet of the table is completely faulty in that it assumes the 241,000 catch is all released to later die at a 3-9% rate. In fact, the catch is all kept. Estimates of caught and released fish are not considered. Most caught and released fish are wild or unmarked hatchery steelhead (1,425 in 1990). The Buoy 10 fishery handles some sublegal salmon. A few Columbia chinook are caught and released during the summer steelhead fishery mid-May to July.

Applying "hooking mortality" estimates to harvest data from fisheries which are not regulated as "catch and release", or where fish are not regularly released, is erroneous.

Page 229, Table 1.1-25. 1990 Catch Numbers of Individual and Combined Oregon Salmonid Fisheries.

The table lists the individual catch total of all of Oregon's salmonid fisheries in 1990 at 1,080,000 fish. The table is deficient in that it does not include the sport catch in Oregon's Columbia River tributaries (100,100 fish in 1990) as an entry; however, the 100,100 fish are included in the total. The authors have included the Washington catch in the Buoy 10 and main-stem lower Columbia sport fisheries. The Oregon and Washington cutthroat trout catch in the main-stem lower Columbia sport fishery is also included in this table.

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In the "Combined Fisheries" section of the table, the authors have separated catches into marine and freshwater and commercial and sport. The authors have included the Buoy 10 catch in the marine category. The states and PFMC separated the Buoy 10 fishery from the ocean in 1982 and since 1982 have considered it a freshwater (Columbia) fishery.

Page 230, Tables 1.2-1. to 1.2-4.

The source for Tables 1.2-1, 1.2-3, and 1.2-4 is noted at the bottom of the tables as NPPC (Unpublished). The Department did not attempt to verify these tables. The source for Table 1.2-2 is noted as PNNC (Unpublished). The Department is not familiar with this acronym and it is not listed in Glossary. The Department did not attempt to verify this table either.

Page 234, Table 1.2-5. Ocean Coast and Columbia River 1990 Salmonid Catch and Escapement Numbers.

This table lists various species-runs of salmonids with total catch compared to escapement goals and actual escapement. A fifth column provides "Notes" relative to the results for each species-run. The table has two parts, Oregon Coast and Columbia River.

This table has considerable problems. The "apples and oranges" comparison problem seen in some earlier tables is present here too. For example, in presenting data for wild coho salmon the total Oregon marine catch of all stocks of coho (hatchery and wild) is reported as 322,300. This catch is then compared to an escapement goal of 161,000 (the 1990 goal for wild Oregon Coastal Natural coho) and an actual escapement number of 68,600 which again is OCN coho. The actual harvest of wild coastal coho was 171,100 (not 322,300), and the escapement was 104,200 (not 68,600, a preliminary estimate by PFMC (1991)). Hatchery coho harvest should not have been included in these estimates. These comments are also pertinent to errors discovered in Table 1.2-8.

The "apples and oranges" comparison problem also applies to data for Oregon Coast chinook and several Columbia species-runs. However, for Columbia species-runs it is difficult for us to determine which are "apples" and which are "oranges" as there are so many errors in the data presented. For example, total catch is listed for 17 Columbia species-run. Of the 17 entries, seven listings are correct and 10 are incorrect. Some of the errors list catches 600% higher than actual. This table lists 1990 escapement goals for three coastal and 17 Columbia species-runs. Three Columbia goals are incorrect. In the listings of actual escapements versus goals there are seven errors for the 17 Columbia species-runs. Several of the notes offer erroneous information. Even the column listing species-run is in error in that the authors have assumed all upriver spring and summer chinook and upriver bright fall chinook are wild. In fact the majority of upriver spring and summer chinook are hatchery produced.

Other errors are also present. There is no mention of Columbia River hatchery summer steelhead returns. This species-run has performed well recently with some returns exceeding 300,000 annually. Coastal hatchery coho is also not mentioned. There are indentation problems in the column for species-run leading to reader

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confusion. The sources include ODFW and WDF (1991) (erroneously cited) and ODFW (1992) not listed in References.

Page 235, Table 1.2-6. Summary of 1990 Oregon Salmon Escapement Goals, Compliance for the Major Coastal Rivers and Columbia River Stocks, and Compliance Status of Eight Wild Salmon Stocks.

This is a two-part table. The first part is a summary for salmon only (does not include steelhead) from the previous table. This table shows eight salmon stocks met the escapement goal and six did not meet the goal. With all the problems we listed earlier for Table 1.2-5 we have no confidence at all in the accuracy of information displayed here.

The second part of the table is more clear in that "1990 Wild Salmon Stock Escapement Compliance" is rated under headings of "goal met" or "goal not met." Under the headings are listed the species-runs. The ratings are accurate for 1990 for seven categories. However, for three of the seven we point out the species-runs listed are not wild but are a combination of hatchery and wild fish. The eighth category is Snake River spring chinook and it is listed as "goal not met." The Department certainly concurs but points out that this category is double-counted in that it is a component of upper Columbia spring chinook and that category is also listed as "goal not met." It is the extremely low level of the Snake River component that causes the upper Columbia spring chinook category to fall into "goal not met."

Page 236, Table 1.2-7. Oregon Coastal Fall Chinook Index.

This table continues the "apples and oranges" comparison observed in previous tables in that it shows Oregon coastal chinook catch (ocean sport and commercial catch and, since 1978, tributary sport spring chinook catch - the authors probably intended to include the tributary sport fall chinook catch) compared to escapement based on adults per mile from stream surveys. The spawning escapement data is an accurate reproduction of Table B-12 from the 1990 "Review Report" from PFMC. The "apples and oranges" comes into play in that north-migrating Oregon coastal fall chinook comprise a very small percentage of Oregon's ocean chinook catch. Furthermore to include coastal tributary spring chinook catch as a factor in whether Oregon's coastal fall chinook escapement goal is met is wrong.

Page 237, Table 1.2-8. Estimated Total Escapement and Goals of Oregon Coastal Coho Salmon and Total Freshwater and Ocean Catch of Sport and Commercial Fisheries, 1971-90.

This table lists total ocean catch and coastal tributary sport catch of hatchery **and** wild coho compared to the Oregon Coastal Natural (OCN) escapement. The escapement is compared to the goal to determine a yes or no annually if the goal was met. It is not clear where these catch estimates were derived as they do not resemble those presented in PFMC (1991), Table III-4. These estimates appear to be inflated if they are intended to represent the catch of wild coastal coho.

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A comparison of the total coho catch to OCN escapement is irrelevant in that the majority of the ocean catch is comprised of Columbia River hatchery stocks. A relevant comparison would be the ocean and coastal tributary catch of OCN compared to OCN escapement. These data problems were also identified and discussed for information presented in Table 1.2-5.

Page 238, Table 1.2-9. Numbers of Upriver Wild Spring Chinook Salmon Adult Catch and Estimated Escapement for the Columbia River, 1970-90.

The intent of this table is to display Columbia River wild spring chinook runs relative to the escapement goal. Catch is also displayed. All the data shown are combined hatchery and wild spring chinook. There are four typos and one error in the data. Furthermore, the escapement number for 1971-90 is compared to a goal established in the mid-1980's. This comparison then yields a "Yes or No" determination if the goal was met. The error (1986) yielded an inaccurate determination. The escapement goal used for determination (115,000) is the combined hatchery and wild goal. Considering earlier escapement goals, several of the "No's" for earlier years would be "Yes." The source for the data is ODFW and WDF (1991), erroneously cited.

Page 239, Table 1.2-10. Numbers of Upriver Wild Summer Chinook Salmon Adult Catch and Estimated Escapement for the Columbia River, 1970-90.

This table suffers from many of the same problems as the previous table. The data presented is for the hatchery and wild components combined. The authors have listed the correct hatchery and wild goal and their determination if "Yes" or "No" for goal met are all correct. However this 100% correctness rate is nearly magical considering there are 16 data errors in the table. The source is ODFW and WDF (1991), erroneously cited.

Page 240, Table 1.2-11. Number of Lower River Wild Fall Chinook Adult Catch and Estimated Escapement for the Columbia River, 1980-90.

This table lists catch, escapement, and whether goal was met. The table is an accurate reproduction of Table 38 from ODFW and WDF (1991) but is not listed as the source. The curious thing about this table compared to the previous two is that all of the data is correct, but a fictitious escapement goal is used by the authors for comparison. This goal is three times the actual goal. Using the correct goal yields "Yes" for all years under the "Met" column.

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Page 241, Table 1.2-12. Numbers of Upriver Wild Fall Chinook Salmon Adult Catch and Estimated Escapement for the Columbia River, 1971-90.

This table compares Columbia upriver bright fall chinook catches and escapement and determines annually if the escapement goal has been met. The authors have erroneously assumed all URB are wild. Data is from PFMC's 1990 "Review Report." There are two errors in the data presented. The escapement goal used to compare to escapements beginning in 1971 was established in the early 1980's.

Page 242, Table 1.2-13. Numbers of Upriver Wild Sockeye Salmon Adult Catch and Estimated Escapement for the Columbia River, 1970-90.

This table (similar to the previous four) lists sockeye catch and escapement and compares it to a goal (a goal that was established in the early 1980's). This table is an accurate reproduction of 1970-90 data from Table 41 in ODFW and WDF (1991), erroneously cited. To compare 1970's data to an early 1980's goal does not make much difference in this situation as the 1970's sockeye returns in most years were below fishable levels even under the 1970's goal.

Page 243, Table 1.2-14. Estimated Harvest Rates for Selected Oregon Adult Salmonids, 1961-90.

This table attempts to show total fishery harvest rates on total Columbia coho (early and late stock combined), lower river wild fall chinook, and upriver bright fall chinook production. It should be noted that the table is titled "Oregon Adult Salmonids"; however, over half of the Columbia River coho originate in Washington as does the vast majority of lower river wild and upriver bright fall chinook.

The Department checked the harvest rates using ODFW's data sources:

7. Ocean harvest rates for coho;

1961-69	Did not investigate
1970-89	Agree for 11 years and for the remaining 9 years disagree, but only by .01 each year
1990	ODFW estimates .61

8. Columbia River coho;

1961-69	Did not investigate
1970-89	Agree for 17 years and for the remaining 3 years disagree, but only by 0.1 each year
1990	ODFW estimates .45

9. Total coho

1961-69	Did not investigate
1970-89	Agree for 19 years and for the remaining year disagree, but only by .01

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1990 ODFW estimates .79

The coho total harvest rate estimates assumes there is a direct 1:1 transfer of adult coho from the ocean to the river and no natural mortality occurs.

10. Ocean chinook salmon

    The Department did not verify

11. Lower river fall chinook (river)

    1980-90 Agree for 8 of the 11 years

12. Lower river fall chinook (total)

    1980-90 ODFW disagrees

13. Upper river fall chinook (river)

    1970-90 Agree for only 5 of the 20 years and only if dam passage loss is not a factor

14. Upper river fall chinook (total)

    1970-90 ODFW disagrees

The Department disagrees with the method the authors used to calculate the chinook total production harvest rates. Their method is flawed in that no adult equivalency factor was applied to the ocean catches to make them relative to the return to the Columbia 0-3 years hence if the fish were not caught.

Page 244, Table 1.2-15. Oregon Provisional Anadromous Salmonid Population Summaries.

This table is an accurate reproduction of a table from ODFW's Wild Fish Management Policy--Biennial Report presented to the Oregon Fish and Wildlife Commission in January 1992. The authors list the source as ODFW (1992), but it was not included in the References.

Page 259, Table 2.2.7-3 Estimated Adult Salmonids Consumed by Seals and Sea Lions in Oregon Waters, 1990.

The estimated losses of salmonids from marine mammal predation presented in this table are likely to be highly erroneous. This table is simply a set of roughly estimated numbers multiplied by more roughly estimated numbers, and so on. The assumptions inherent to these calculations are questionable: for example, it can not be assumed that a pinniped would eat 2.5 lb. of salmon per day for 365 days; it is incorrect to assume

that salmon are available to all pinnipeds each day of the year; etc.. In addition, the outcome of these calculations can be altered significantly by changing a few of the estimates slightly. For example, there are probably a lot more than 200 California sea lion over-winter migrants and more "resident" northern sea lions. Increasing these numbers would increase the estimated consumption and alter the percentages given. On the other hand, if more accurate consumption rates for Steller sea lion sex and age classes were used, the estimated consumption for this species would decline. These types of estimates are very inaccurate and imprecise. A wide range of desired outcomes could be achieved depending upon the information used, and the assumptions incorporated into the analysis. Extreme caution should be used when comparing these estimates to "hard" estimates such as commercial fishery landing data.

REVIEW OF HARVEST FIGURES

The review of the figures presented in the report was primarily limited to figures presenting fishery harvest information. Figures not discussed in this section were not verified for accuracy.

Page 265, Figure 1.1-1. Lower Columbia River Landings of Chinook Salmon.

This figure appears to be an accurate representation of chinook landings in pounds for the entire Columbia (Indian and non-Indian) commercial fishery. However, the title of the figure is misleading in that it says lower Columbia (indicating below Bonneville Dam). Also, the title does not indicate these are commercial landings only. Three sources are cited; however, only two are listed in the References.

Page 265, Figure 1.1-2. Lower Columbia River Landings of Sockeye Salmon.

This figure has many problems. The intent is to show total Indian and non-Indian commercial landings from the entire Columbia. Similar to Figure 1.1-1 the title does not say this. Both axis are mis-labeled. The y-axis is supposed to be millions of pounds and it is graduated from 0 to 50 million (a 10-fold exaggeration). Clearly, it should be graduated from 0 to 5 million. This is a very critical feature of the figure in that it portrays an image of historic landings plummeting from 40-50 million pounds annually to 0 in the present. Compounding the problem is that the authors failed to mention there had been no commercial sockeye fishery in 12 of the last 18 years. Additionally, the authors display landings for the early years that do not agree with our records. On the x-axis the early years do not match the peak catch years as we know them and a typo exists for 1900.

In addition, three sources are cited; the first is accurate and listed in References, the second is not listed in References, and the third (as was the case for this source in many of the harvest tables) is erroneously cited in that it refers to the Clackamas Subbasin Plan, when in fact the data is from ODFW and WDF (1991). This error is carried through on many of the following harvest figures.

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Page 266, Figure 1.1-3. Lower Columbia River Landings of Steelhead Trout.

This figure has the same title and source errors as Figure 1.1-2. The data for the early years do not agree with our records. The figure does not state that steelhead landings by non-Indians have been prohibited since 1975.

Page 266, Figure 1.1-4. Lower Columbia River Landings of Coho Salmon.

This figure has the same title and source errors as Figure 1.1-2. The data for the early years match up reasonably well with our records. It appears the x-axis (years) is off slightly.

Page 267, Figure 1.1-5. Lower Columbia River Landings of Chum Salmon.

This figure has the same title and source errors as Figure 1.1-2. The data for the early years match up reasonably well with our records. It appears the x-axis (years) is off slightly.

Page 267, Figure 1.1-6. Lower Columbia River Total Landings of All Salmonids.

This figure has the same title and source errors as Figure 1.1-2. The data for the early years match up reasonably well with our records. Similar to the previous figures it appears the x-axis (years) is off slightly.

Page 268, Figure 1.1-7. Steelhead Trout Oregon Coastal River Landings.

Data trends match our records, but the y-axis scale seems to be off approximately 100,000 pounds. This figure shows landings declining steadily to near 0 in the late 1940's. The decline is primarily the result of season closures, which prevented fishing for steelhead. This should be acknowledged by the authors.

Page 269, Figure 1.1-8. Trends of Salmon Populations in Oregon.

This figure is a perfect tracing of Figure 3 in McKernan, et. al. 1950. Unlike McKernan et. al.'s footnote, the authors misspelled deviation. In the References, McKernan, et. al. is wrongly attributed to transactions from a "conference."

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Page 270, Figure 1.1-9. Columbia River Commercial Indian Catch of Salmon and Steelhead Trout.

This figure is an accurate depiction of the treaty commercial landings. The source is ODFW and WDF (1991), but once again the citation is erroneous.

Page 270, Figure 1.1-10. Columbia River Commercial Landings of Salmon and Steelhead Trout.

This figure is an accurate depiction of percentage catch by Indians and non-Indians. The source is ODFW and WDF (1991), erroneously cited.

Page 271, Figures 1.1-11, 1-1-12, and 1-1-13. Pacific Coast Annual Landings of Troll Caught Salmon. Annual Troll Chinook Landings by Area; Annual Troll Coho Salmon Landings by Area.

The Department could not verify these tables as the source (PSFMC, 1990) is not listed in the references.

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Coordinated Tribal Water Quality Program

A Proposal Submitted To The United States Congress And United States Environmental Protection Agency
By The Federally Recognized Indian Tribes In Washington State

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Executive Summary:

To address water quality issues affecting their reservation and off-reservation resources, the federally recognized tribes in Washington state have developed the Coordinated Tribal Water Quality Program. The program, currently in Stage II of development, will address water quality issues through a cooperative watershed approach.

Western Washington tribes that took part in the program's development are the Chehalis, Hoh, Jamestown S'Klallam, Lower Elwha Klallam, Lummi, Makah, Muckleshoot, Nisqually, Nooksack, Port Gamble S'Klallam, Puyallup, Quileute, Quinault, Sauk-Suiattle, Shoalwater Bay, Skokomish, Squaxin Island, Stillaguamish, Suquamish, Swinomish, Tulalip and Upper Skagit. All of these tribes, except for the Chehalis, Shoalwater Bay and Hoh, are members of the Northwest Indian Fisheries Commission. Eastern Washington tribes that took part in developing the program are the Colville, Kalispel, Spokane and Yakima. Together these tribes have recognized management and co-management rights that extend to nearly all of the main watersheds and marine waters in Washington state.

The need for new approaches to water quality problems stems from a simple fact: Water pollution threatens survival of the fish, wildlife and other natural resources on which the tribes depend, endangering the economic and cultural core of tribal life. The tribes feel these issues must be resolved cooperatively and in partnership with federal, state and local governments rather than through litigation.

"The tribes in Washington state are dependent on clean water for the natural resources that are the basis of our cultural, economic and spiritual health. The Coordinated Tribal Water Quality Program represents our best efforts to develop a statewide tribal water quality program that will allow us to successfully address the many water quality problems that we confront."
– Bill Frank, Jr., Chairman, Northwest Indian Fisheries Commission

The Coordinated Tribal Water Quality Program is built upon four flexible, interconnected stages that are driven by funding, not by time. The stages do not imply that each tribe would arrive simultaneously at the same point in program development. That would be impossible because of differences in tribal sizes, needs and water quality problems. The stages do, however, outline what the tribes think can be accomplished through planned effort, coordinated budgeting, intergovernmental goodwill, and appropriate funding. A full discussion of the staging within the Coordinated Tribal Water Quality Program begins on page 17.

Stage I consisted of program development that was conducted on the basis of interviews with tribal policy makers and technical staff at each federally recognized tribe in the state. These interviews:

- Outlined water quality issues affecting reservation and off-reservation waters;
- Identified tribal programs currently in place to address water quality issues;
- Identified actions needed to combat water quality issues; and
- Determined change in relations with other governments that could lead to comprehensive, coordinated and cooperative efforts to address water quality issues.

Stage II of the program provides infrastructure for each tribe to integrate its specific issues into the overall program guidelines. The tribes, through this initial infrastructure development, will also be able to refine and complete the program development by acquiring needed expertise and staff.

Stage III of the program has three components. The first allows each tribe to implement the base-level water quality program designed in stages I and II. These basic programs would include the staff, equipment, and support costs necessary for the tribes to begin addressing water quality issues affecting their reservations and treaty-protected resources, and accomplishing program goals. The second would extend tribal water quality programs, implement regional programs and increase statewide programs. The third component provides for maintenance of tribal programs, extension of water quality education efforts and planning of tribal watershed demonstration projects. Each of these components are inter-dependent, and when combined create a meaningful mechanism for water quality protection efforts.

"Through much hard work and perseverance, the State of Washington has built a strong working relationship with Indian tribes on matters of resource management. We share a mutual interest in seeing timber, fish, wildlife and agricultural resources protected and managed so that they remain healthy and strong for everyone's benefit. I would like to add my endorsement to the tribes' request for federal support of their role in these efforts. The money, I can assure you, will be well-spent."
-- Booth Gardner, Governor, State of Washington

The Coordinated Tribal Water Quality Program rises from a comprehensive, cooperative natural resource management process that is becoming institutionalized in Washington state. The federally recognized tribes in Washington state have been a driving force behind this process, which is already being used to manage salmon and forest lands.

Participating tribes are sovereign governments with treaty and other legally protected rights to clean water both on and off-reservation. As such, they possess jurisdictional authority and legally protected property rights in most of the state's major watersheds. The comprehensive, coordinated approach to natural resource management now being employed in Washington state is based, however, on the firm knowledge that cooperation, not litigation, is the best way to resolve natural resource issues.

The tribes now want to apply this same successful approach to water quality issues through the Coordinated Tribal Water Quality Program. The benefits of this program's watershed approach to water quality issues have been evident for some time and have been consistently supported by the tribes, U.S. Environmental Protection Agency (EPA) and the State of Washington. Water pollution does not respect jurisdictional boundaries. This natural watershed management approach replaces jurisdictional walls with partnerships that improve efficiency and increase effectiveness.

"EPA is committed to meaningful implementation of our Indian Lands Policy on a government-to-government basis. Development and implementation of innovative watershed strategies to solve pollution problems is an important agency priority. This strategy will go a long way to promote identification of watershed problems and cooperation among federal, tribal, state and local efforts to address these problems." *-- Julie M. Hagensen, EPA Assistant Regional Administrator for Washington Operations*

Full implementation, Stage IV of the Coordinated Tribal Water Quality Program, requires $10 million. This is an initial conservative estimate based on preliminary knowledge of program needs. A more precise estimation of cost will be developed during Stage III. Operation at this optimum level includes:

- Maintaining the general tribal water quality programs;
- Implementing education programs;
- Implementing watershed demonstration projects;

- Supporting specific tribal projects; and
- Providing funding opportunities to non-tribal governments to assist them in working cooperatively with tribal governments on water quality issues.

To date, Stage I program development and Stage II development of tribal infrastructure are being accomplished. The next step -- development, implementation and extension of initial tribal, statewide and regional programs -- will require $6 million annually.

The following figure shows the program's stages of developments and the funding associated with each:

Program Design
and
Implementation Schedule

Stage I	September, 1990 to January, 1992	Program Development	Yearly Cost: $194,000
Stage II	September, 1991 to October, 1992	Develop Water Quality Program infrastructure for each tribe and begin statewide coordination	$1,500,000
Stage III	FY93	Development of initial tribal and coordinated statewide programs Extend tribal water quality programs and effect regional programs and increase statewide programs Maintain tribal programs and add special tribal projects	$5,000,000
Stage IV	FY94	Full implementation of national tribal model water quality program	$10,000,000

Participating tribes want the program's new coordinating mechanisms and technical efforts to build on, enhance and complement existing endeavors of individual tribes and other entities to improve water quality. The Coordinated Tribal Water Quality Program is not intended to replace those ongoing programs nor to compete with them for funding. The tribes want the program to build on, complement and strengthen cooperative water quality partnerships that they have sought to develop with other governments and private entities.

The tribes participating in the Coordinated Tribal Water Quality Program believe that fully-funded, cooperative efforts to protect and cleanse the waters in Washington state are less expensive and more productive in the long run than litigation or legislative struggles to achieve the same end. Through this program the tribes plan to achieve for waters within the State of Washington, and particularly for waters of tribal concern, the same goal of the federal Clean Water Act: To restore and maintain the chemical, physical and biological integrity of the nation's waters. Through this program the tribes also plan to protect and preserve their cultural and economic well-being.

Introduction:

"The shining water that moves in the streams and rivers is not just water but the blood of our ancestors. If we sell you our land, you must remember that it is sacred, and you must teach your children that it is sacred, and that each ghostly reflection in the clear water of the lakes tells of events and memories in the life of my people. The water's murmur is the voice of my father's father. The rivers are our brothers, they quench our thirst. The rivers carry our canoes, and feed our children. If we sell you our land, you must remember, and teach your children, that the rivers are our brothers, and yours, and you must henceforth give the rivers the kindness you would give any brother."

-- *Chief Sealth during treaty times.*

*****

Water pollution threatens tribal health. It also threatens the survival of natural and cultural resources on which the tribes depend. To safeguard their health and those resources, the federally recognized tribes in Washington state want to exercise their treaty and other powers to protect, restore and enhance watersheds of tribal concern and their associated ecosystems.

Individually, each tribe intends to continue to exercise its sovereign authority on a government-to-government basis with other tribes, as well as federal, state and local governments to achieve common goals. At the heart of the effort, each tribe is attempting to inventory, assess, prioritize, regulate and eliminate water pollution within its waters of concern. Equally important, however, lies the recognition that addressing water pollution requires cooperative, coordinated efforts in alliance with other governments.

Water pollution ignores jurisdictional boundaries. Tribal jurisdictions border and interlock with other jurisdictions, including those of the most densely populated and industrialized areas of Washington state. The tribes realize that alone they cannot successfully combat water pollution. Prevailing against water pollution requires concentrated, sophisticated and both technical and political methods. The tribes therefore have committed themselves to the development of a model coordinated tribal water quality program outlined in this report.

Intergovernmental coordination between tribes, federal, state and local governments and other entities is crucial to controlling water pollution. The tribes need considerable financial and technical assistance in evolving and expanding their water quality programs -- financial help that is sufficient and consistent.

The tribes want to secure sufficient, predictable federal funding to guarantee development and implementation of their water quality programs and to institutionalize congressional and executive support. Perhaps more than other governments, the tribes understand from long experience that limits apply to funding. To make every dollar work to its fullest, they plan to multiply the effects of the dollars they receive by joining with other governmental entities and organizations in coordinated, cooperative efforts to address impacts on water quality.

Well before 1987, when Congress authorized federally recognized tribes to attain the status of "states" under the Clean Water Act, the tribes in Washington had taken a

lead in developing comprehensive, cooperative and coordinated agreements with state and local governments and private interest groups to protect and manage natural resources, especially those resources essential to the survival of salmon and trout.

The drive for such agreements arose out of decades of successful litigation brought by treaty tribes and the United States against the State of Washington to protect tribal fishing rights to salmon and other fish, including the right to fish off-reservation in usual and accustomed fishing areas. Decisions in federal courts so far have not only ensured these tribal treaty fishing rights but have established the treaty tribes as co-managers of the fisheries resource.

In the process, courts also declared that the tribal fishing rights are meaningless if there are no fish to harvest. The courts noted that certain environmental conditions are prerequisite to the survival of salmon. These conditions include:

- Access to and from the sea;
- Sufficient and suitable gravels for spawning and incubation of eggs;
- An ample supply of food;
- Sufficient shelter in all stages of development; and
- *An adequate supply of good quality water.*

A federal court ruling which held that state and federal governments must refrain from degrading fish habitats put the matter this way:

"Were this trend to continue (environmental degradation), the right to take fish would eventually be reduced to the right to dip one's net into the water and bring it out empty."

From the Washington State Attorney General's office then came the observation that the ruling could confer upon treaty tribes the power to co-manage all activities in many of the state's watersheds:

"...the ruling could lead to the tribes' having veto power over real estate projects, logging practices, highway construction and the use of pesticides in the western half of the state..."

Such litigation, however, taxed tribal time, staffs and treasuries. It also taxed the State of Washington and complicated already highly complicated fisheries. Tribal and other participants all observed that litigation was not producing any more fish, nor was it making the state's fresh and marine waters any cleaner.

More broadly, out of the actions in the courts, some of them still ongoing, grew an earnest desire among tribal leaders to seek coordinated cooperative agreements on managing natural resources that would achieve the same management ends as litigation. The same desire arose within present and past administrations of the State of Washington. Private observers of how the court decisions might impact their enterprises, especially those harvesting timber, also became interested in such an approach.

What followed were agreements -- unique in the nation -- that brought previously contending tribes and other parties together in a voluntary process to serve mutual needs. In summary, the evolution of cooperative resource management so far has produced:

- Tribal/state ongoing plans for cooperative management of Puget Sound fisheries. These plans join the tribes involved and the state departments of Fisheries and Wildlife in mutual concerns about water quality and streamside and in-stream habitat.

"We are very encouraged by and support the tribes' efforts to expand their participation, involvement and expertise in water quality issues. We advocate coordinated cooperative efforts to develop solutions to water pollution problems on a watershed/ ecosystem basis. The resources of the state will be served by greater participation by tribal governments in protecting water quality." -- *Joseph Blum, Director, Washington Department of Fisheries*

- The Pacific Salmon Treaty between the United States and Canada, which resulted in 1985 from joint efforts by tribes, state government, sport and commercial fishing groups and federal fisheries officials. The treaty set up an administrative mechanism -- in which the tribes have a strong voice -- for cooperative management and protection of each nation's fish.

- A cooperative system of watershed planning developed in 1986 by the tribes and the state Departments of Fisheries and Wildlife. The process aims to manage and enhance salmon fisheries on a watershed basis. The tribes and the state departments solicited public comments, held hearings, developed sub-regional work teams that identified goals and objectives and problems and opportunities for each watershed, and have since developed Comprehensive Resource Production and Management Plans for each drainage. These plans receive constant updating in light of results and changes in resource conditions. Such cooperative, ongoing planning and management efforts accord with tribal aims through the Coordinated Tribal Water Quality Program to apply cooperative techniques to solving water quality problems on a watershed or ecosystem basis.

"The protection of our state's natural resources requires that the state and tribes work closely together. It is imperative that the tribes obtain the level of funding needed to make this partnership work. Without this support the natural resources of our state will surely be seriously diminished." -- *Curt Smitch, Director, Washington Department of Wildlife*

- The Timber/Fish/Wildlife Agreement of 1986 by which tribes, state agencies, environmentalists and private timber owners seek to find regulatory and voluntary ways to protect streams and watersheds from the impacts of logging. Water quality impacts from timber harvest practices remain a main concern of all the tribes. The Timber/Fish/ Wildlife Agreement affords a cooperative way to apply best-management practices to timber harvests.

"Tribes have played a key role in our consensus approach to controversial natural resource issues in Washington state. Their participation benefits not just the tribes, but everyone in our state who is concerned about protecting our environment. It is critical that they have the funding to continue their important contributions." -- *Brian Boyle, Washington State Commissioner of Public Lands.*

- The Centennial Accord of 1989 between the tribes and the State of Washington, which recognizes and respects the sovereignties of tribes. The pact also institutionalizes a government-to-government relationship between the state and the tribes. This agreement infuses tribal determination to deal with water quality problems in coordinated, cooperative approaches that transcend boundaries.

- The tribal/state Environmental Memorandum of Understanding of 1989 by which the state recognizes tribal sovereignties and pledges to work on a government-to-government basis to protect, restore and enhance fish and wildlife habitats.

- Tribal participation in the governance and work activities of the Puget Sound Water Quality Authority, created in 1985 to develop a comprehensive plan for protecting the water quality of Puget Sound. Tribes in the Puget Sound basin put restoring the water quality of Puget Sound as a main priority to be achieved through their cooperative efforts in the Coordinated Tribal Water Quality Program.

"Ecology shares the tribal goals to resolve cross-boundary and shared-resource environmental issues through intergovernmental approaches. In order for this to be successful, tribes must have the staff resources to effectively participate in the many forums affecting them." – *Chuck Clarke, Director, Washington Department of Ecology*

- The Puget Sound Estuary Program, established with the designation of Puget Sound as an Estuary of National Significance. The program is co-managed by EPA, the tribes, the Washington Department of Ecology and the Puget Sound Water Quality Authority. The tribes are represented on the Authority as co-managers of Puget Sound waters and serve on the estuary program's management committee.

- The Chelan Agreement of 1990 by which the tribes, the state, environmental groups, agriculturalists, counties and cities and other water users seek cooperative ways to protect and enhance water resources. Water shortages loom in all parts of Washington and the quantity of water frequently determines the quality of water.

"Water is, and will continue to be, of overwhelming importance to this state. It is absolutely necessary that the tribes be able to participate in the decision-making processes, and we support your efforts to obtain funding." – *C. Alan Pettibone, Director, Washington Department of Agriculture*

All of these agreements and programs deal with evolving processes. The tribes and other participants hope that these processes will lead to environments that protect fish, wildlife and other resources, thereby enriching the common quality of life for tribal people and all others.

Tribes -- whether they live on Puget Sound, the Pacific Coast or along the drainages of the Columbia River in eastern Washington -- are committed to managing water quality on a watershed/ecosystem basis that transcends jurisdictions. This approach commits all jurisdictions to plan together, to act together and in doing so to respect each other's powers and dignities.

The tribes are not blind to history. Until lately, and only after they went to court to protect their rights, they were often the last jurisdictions invited to manage such common resources as water. On a local level they are still sometimes overlooked in planning that impacts reservations and tribal lands, waters, fish, and other resources. The tribes also are aware that not until lately did the federal government begin to see them as significant forces in the battle against water pollution -- even though the reservation tribes nationally control an area larger than New England and have sovereign, treaty and court-derived rights to regulate water quality. The tribes in the State of Washington, for example, have management or co-management rights in nearly all of Washington's major watersheds.

The tribes also note that even after Congress -- in the Safe Drinking Water Act and the Clean Water Act -- delegated authority for environmental protection to the tribes, sufficient money to carry out tribal environmental responsibilities and desires has not been forthcoming. The tribes look to Congress to treat them as equals with other governments when it comes to providing funding for addressing water quality problems. Nevertheless, the tribes know -- indeed, have championed -- the premise that water pollution cannot be controlled and ended without all parts of the national community working together.

The Coordinated Tribal Water Quality program that has evolved among tribes in Washington state reflects three complimentary matters:

- The necessity for each tribe to control its environment to protect its future;
- The necessity to enhance that control by reaching out to other entities to combat water pollution and to restore water quality; and
- The necessity to improve current efforts to address water pollution by utilizing them, building on them and ensuring that they are complemented by new water quality programs.

These necessities are reflected in the goals and objectives the participating tribes have set for the Coordinated Tribal Water Quality Program:

Goals:

Tribes participating in the Coordinated Tribal Water Quality Program agree on these general goals:

- To achieve for waters within the State of Washington, especially for waters of tribal concern, the goal of the Clean Water Act to restore and maintain the chemical, physical and biological integrity of the nation's waters;
- To develop and implement a coordinated, cooperative tribal water quality program to protect and conserve treaty rights and the political integrity of the tribes and of their citizens and environments;
- To maintain, restore, and enhance biotic diversity and functions within ecological communities in the State of Washington so that an overall net gain in the productive capacities of fish and wildlife habitats is achieved; and
- Tó promote respect for traditional tribal values about water and the environment.

Objectives:

Tribal water quality goals will be met through the attainment of objectives that the individual tribes have set for themselves. Not every participating tribe will fulfill every objective. However, by utilizing the coordinated intergovernmental strategy described later in this report, the participating tribes intend collectively to achieve objectives such as:

- Establishing within each tribe an initial, base-level water quality program to address nonpoint source pollution and other water resource problems;
- Coordinating each tribe's program with intertribal and intergovernmental efforts to address water pollution on a watershed/ ecosystem basis;
- Developing water quality testing facilities for tribal use;
- Creating a statewide water quality information and data management system for the tribes;
- Building on existing agreements with federal, state and local governments to develop new model watershed programs that will hasten clean-up and prevention of water pollution and restoration of streamside and in-stream habitats;
- Intensifying tribal efforts to ensure enforcement by other governments of existing laws, regulations and agreements to protect water quality, water quantity, water use and riparian, in-stream and marine habitats, especially those used by salmonids;
- Increasing tribal involvement in permitting processes for activities that may harm water quality and quantity;
- Increasing awareness of the public and public officials of the need to conserve biological diversity and of the role of the tribes in that activity; and
- Implementing tribal watershed demonstration projects involving intergovernmental efforts in water quality protection.

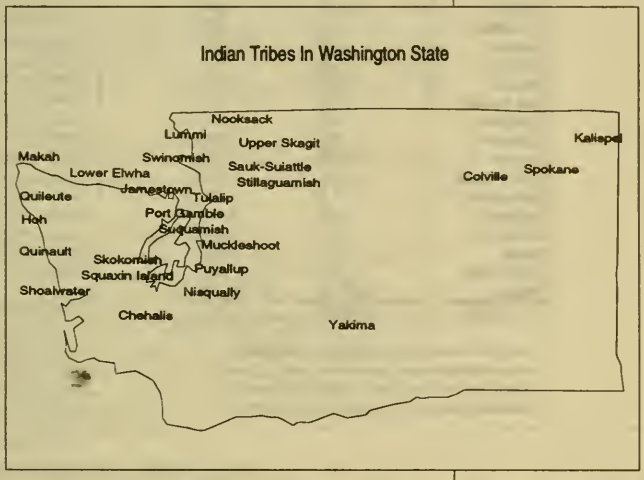
Tribal Water Quality Concerns:

Federally recognized tribes in Washington state confront serious water pollution problems but lack the means to overcome them. The tribes face many types of water pollution because tribal and reservation lands and waters and treaty management areas border and interlock with Washington state's major logging, agricultural, industrial and population centers. The following figure indicates the locations, dimensions and populations of tribal reservations in the State of Washington. The main sources of pollution degrading tribal waters are:

- Logging and other silvicultural practices;
- Agricultural practices;
- Shipping accidents creating major oils spills;
- Urbanization, general growth and development;
- Failing septic systems;

- Stormwater runoff and combined sewer overflows;
- Municipal and industrial discharge;
- Operations of hydroelectric projects;
- Industrial point source pollution;
- Municipal and industrial water diversions;
- Mining; and
- Boating and other recreational activities.

Many of these sources of pollution originate off of tribal reservations, yet threaten tribal health and well-being. They especially threaten the survival of salmon, steelhead, shellfish and other natural resources that the tribes rely on for their economic and cultural well-being. Each tribe harvests fish for ceremonial, subsistence and commercial uses. The tribal catch of salmon ranges from 2 million to 5 million fish per year.



Nearly all of the tribes operate hatcheries and other fish-rearing facilities to supplement stocks of wild fish. These facilities produce 50 million juvenile fish annually. Some marine tribes also operate facilities to grow and prepare shellfish for market.

Nonpoint source pollution degrades waters on tribal reservations and in off-reservation waters over which treaty tribes have co-management rights. It also degrades waters outside of the direct scope of tribal management that produce or harbor salmon and trout that transit tribal waters and are part of the tribal catches.

Indian Tribes In Washington State
Reservation Sizes/Populations

TRIBE	RESERVATION (Square Miles)	RESERVATION POPULATION
Chehalis	7.0	491
Colville	2,116.6	6,957
Hoh	0.7	96
Jamestown **	0.1	22
Lower Elwha	0.7	137
Lummi	21.0	3,147
Makah	42.7	1,214
Muckleshoot	6.1	3,841
Nisqually	7.9	578
Nooksack	4.2	556
Port Gamble	1.9	532
Puyallup	28.5	32,406
Quileute	1.6	381
Quinault	325.2	1,216
Sauk Suiattle	0.1	124
Shoalwater	1.2	131
Skokomish	8.2	614
Spokane	327.5	1,502
Squaxin Island	2.5	157
Stillaguamish **	0.1	174
Suquamish	11.7	4,834
Swinomish	11.4	2,282
Tulalip	35.2	7,103
Upper Skagit	0.2	180
Yakima	2,137.6	27,668
TOTAL	5,099.9	96,343

** Data for these tribes was compiled during onsite interviews. Additional tribal members are not represented in the U.S Census data for on-reservation populations. A considerable number of off-reservation tribal members will benefit from this program.

"The Agency believes that where an ecosystem crosses political boundaries, effective regulation calls for coordination and cooperation among all governments having regulatory roles impacting the ecosystem." – *EPA, "Federal, Tribal and State Roles in the Protection and Regulation of Reservation Environments," 1991, p. 5.*

Nonpoint source pollution is pollution that flows from a variety of sources. The EPA, for regulatory purposes, has characterized nonpoint sources as "diffuse sources that are not regulated as point sources." Nonpoint source pollution includes, but is not limited to, siltation from logged hillsides; fecal bacteria from septic tanks and farm animals; pesticides and fertilizers; and municipal and industrial discharge.

Under the Clean Water Act's National Pollutant Discharge Elimination System (NPDES), the federal government, state government and tribes with state status under the Clean Water Act can regulate pollution from point sources such as a single pipe discharging pulp mill wastes. The federal government, however, chooses to use educational programs and best-management practices as the primary methods of controlling nonpoint source pollution.

The NPDES does not, however, regulate all point sources. The Clean Water Act fails to include water pollution from many agricultural sources under the system's scope. Consequently, an irrigation canal that daily discharges millions of gallons of water laden with bacteria and agriculture wastes into the Columbia River or Puget Sound qualifies only as a nonpoint source.

Tribes also are impacted by point source pollution from industrial operations and from municipal sewage-treatment plants. In some cases, it is difficult to distinguish, except in the narrow legal sense, between nonpoint sources of pollution and point sources.

Program Framework: Roles And Responsibilities

The Coordinated Tribal Water Quality Program outlines what relationships the tribes could generate among themselves and with other governments if sufficient funding is forthcoming from Congress. The intergovernmental and programmatic relationships indicated in the discussion that follows show what the tribes plan to accomplish once funding begins to flow.

The Coordinated Tribal Water Quality Program is built upon the following framework:

- Each participating tribe will develop and administer a water quality program for itself through a government-to-government relationship with the EPA and with other tribes and other governmental entities. Such programs would prioritize watersheds for implementing actions, identify those actions, identify other responsible agencies and groups, estimate costs and propose action schedules and milestones.

- Participating tribes would establish or expand existing cooperative arrangements with each other and with federal, state and local entities to address nonpoint source and other water quality problems on a watershed basis.

- To get the Coordinated Tribal Water Quality Program under way, participating tribes initially would coordinate general water quality policies through the Environmental Policy Committee of the Northwest Indian Fisheries Commission. Each participating tribe would be represented on the committee. Monthly meetings of the committee would be staffed and facilitated by the Northwest Indian Fisheries Commission. At least one committee meeting each quarter would be devoted solely to water quality matters. In Fiscal Year 1993 the participating tribes would discuss whether they want to continue using the Environmental Policy Committee as the forum for coordinating water quality policies.

- As an additional measure to launch the program, the Northwest Indian Fisheries Commission would render technical, educational and other services to the Coordinated Tribal Water Quality Program, including forums for technical discussions of water quality matters.

- Through the Environmental Policy Committee, the Northwest Indian Fisheries Commission would offer the participating tribes an avenue for discussing water quality matters with the federal, state and other governments.

- Following adoption of the Coordinated Tribal Water Quality Program, the participating tribes and Northwest Indian Fisheries Commission would make a joint annual report to Congress and to the EPA on the program's evolution, progress and achievements.

- Four years after the adoption of the Coordinated Water Quality Program, the participating tribes would review the program's entire coordinating framework to see if framework changes might improve the joint tribal water quality efforts.

Experience has convinced the tribes that the only reasonable and efficient way to address nonpoint source and other water pollution is on a watershed, ecosystem basis that transcends jurisdictional boundaries. No single governmental entity has been able by itself to confront all of the water quality problems facing Washington state and the treaty Indian tribes. Only comprehensive, coordinated efforts can cleanse waters, restore habitat and sensitize the public about why and how to prevent water pollution.

The tribal commitment to watershed management and planning dovetails with the stated goals, objectives and guidance of the Clean Water Act. In addition, the watershed management approach to water quality concerns furthers those objectives of the Clean Water Act that do not require -- but would benefit from -- the watershed planning process and approach as envisioned by the tribes and State of Washington. Some of the tribal programs would include efforts to:

- Inventory, assess and protect wetlands to achieve a net gain of wetland areas;
- Protect and restore tribal spiritual and cultural areas affected by water pollution;
- Upgrade reservation waste treatment systems;
- Institute cooperative programs for managing active, orphaned and abandoned logging and other roads;
- Identify, classify and monitor ecosystems and biotic communities unique and important to the tribes;
- Coordinate tribal land-use ordinances with those of neighboring governments;
- Have the EPA appreciate and recognize tribal off-reservation rights and authorities;
- Prevent development within riparian areas and flood plains and to facilitate coordination of buyout programs for those living in flood plains;
- Seek increased funding for the water pollution enforcement divisions of tribal, state and local agencies;
- Work with other governments to develop social, political and financial incentives, so that private efforts to curb and stop pollution will be rewarded; and
- Work with other governments to secure funding for research on the water quality and water quantity impacts of silvicultural, agricultural, industrial, and development activities, so that the results of this research will be built into decisions about water quality programs.

As individual jurisdictions, the participating tribes face the necessity to begin preparing themselves with the staff and staff support to take on a full role in dealing with water quality concerns on a watershed basis. The plan the tribes present here for a Coordinated Tribal Water Quality Program recognizes that until 1991 most of the tribes had little money and small or no staffs for handling nonpoint source and other water quality problems.

Tribal Governments:

The framework for the Coordinated Tribal Water Quality Program rests upon the sovereign status of each tribe. The basic unit of the program is and must be the individual tribe. Each tribe will exercise its sovereignty over its efforts to control and eliminate water pollution. In interviews and intertribal forums, the tribes have expressed that in their individual areas of governance, the Coordinated Tribal Water Quality Program shall reflect these principles:

- Each tribe intends to staff, develop, implement and administer its own measures to control water pollution.

- Each tribe intends to begin to institute its water quality program as soon as it receives from EPA the funding to hire at least one staff member with the expertise to begin developing a minimum level water quality program. Tribes may agree to pool staff or jointly contract for staff.

- As part of its water quality program, each tribe intends to inventory its waters, assess nonpoint and other sources and prepare a plan targeting and prioritizing source controls within its waters of concern.

- Each tribe may institute or expand its own facilities for water quality monitoring, assessment and testing. For the sake of efficiency and reduced costs, such water testing programs as far as possible shall complement tribal water testing programs for drinking water, fisheries and shellfisheries.

- Each tribe shall establish its own on-reservation policies and decide for itself the form of the water quality program it chooses to adopt to meet tribal goals.

  Under EPA regulations, a tribe may request EPA to administer water pollution control measures for the tribe. A tribe may adopt and seek to enforce all or part of the State of Washington's water quality standards; or it may agree to let the state enforce authority in tribal management areas. It may adopt and seek to enforce standards of its own that are congruent with the requirements of the Clean Water Act.

- Each tribe adopting on-reservation water quality standards and an implementing program shall ensure that it has in place a tribal administrative code. The code will delineate hearing, appeal and other procedures governing adoption of standards and the implementing program and other tribal ordinances. These procedures are necessary to give full legal foundation to the adoption and enforcement of water quality standards and programs.

- Each tribe shall maintain its government-to-government relationship with the EPA and all other governmental entities. No organization shall speak on water quality policy matters for any tribe unless that tribe agrees to be so represented.

- Each tribe intends to institute for itself an educational program on how to prevent and control water pollution. The tribes recognize education as a major tool for preventing water pollution, especially nonpoint source pollution. Educational programs carrying the tribal voice have strong effect on tribal members and furthermore act to make the tribal voice heard in neighboring non-tribal communities.

Regional And Watershed Coordination:

Circumstances and experience convince the Washington tribes that the success of any water quality program depends on coordinated, cooperative pollution control efforts among the tribes themselves and between the tribes and other governments.

The tribes agree that ongoing and new efforts to protect, restore and enhance the purity of waters within the state must continue to be cooperative and must continue to be carried out on a watershed basis. Watershed programs usually involve a multiplicity of tribal and nontribal governments. As part of the Coordinated Tribal Water Quality Program, the tribes intend:

- Individually, and as groups, to strengthen and institutionalize ties between the tribes and the counties and municipalities in combatting water pollution.

- Individually, and as groups, to strengthen their government-to-government relations with such state agencies as the state departments of Ecology, Natural Resources, Fisheries, Wildlife, Agriculture, Health and Community Development and with the Puget Sound Water Quality Authority.

Many tribes already involve themselves in tribally-directed regional organizations that have evolved from the necessity to jointly manage off-reservation fisheries and other resources dependent upon water quality. These organizations include the Skagit System Cooperative (Swinomish, Upper Skagit and Sauk-Suiattle tribes), Point No Point Treaty Council (Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam and Lower Elwha Klallam tribes) and Upper Columbia United Tribes (Spokane and Kalispel tribes).

With the development and initial funding of the Coordinated Tribal Water Quality Program, these organizations take on additional importance as both technical and policy structures for dealing with nonpoint source and other water pollution. As intra-tribal water quality programs broaden and deepen, these organizations should develop further importance as chief regional tribal entities focusing on watershed water pollution problems in cooperation with non-tribal governments.

Along with the the Skagit System Cooperative, Point No Point Treaty Council and Upper Columbia United Tribes organizations, other options exist for formal and concentrated tribal cooperation in water quality programs. These include:

- The Nooksack River drainage, involving the Lummi and Nooksack tribes;
- The Stillaguamish and Snohomish river drainages, involving the Tulalip and Stillaguamish tribes;
- The heavily populated drainages in King County and the Kitsap Peninsula, involving the Suquamish and Muckleshoot tribes;
- The south Puget Sound drainages in Pierce, Thurston and Mason counties, involving the Puyallup, Squaxin Island and Nisqually tribes;
- The Olympic Peninsula coastal drainages, involving the Makah, Quileute, Hoh, and Quinault tribes;
- The central Columbia River drainages, involving the Yakima Indian Nation and other tribes;
- The Chehalis River drainage, involving the Chehalis and other tribes; and
- The Willapa Bay drainages, involving the Shoalwater Bay and other tribes.

Statewide Coordination:

The Coordinated Tribal Water Quality Program would include one or more centralized offices to provide participating tribes with coordinated technical aid and information. A forum also would be provided at which the tribes may discuss and develop joint water quality policies and from which they may communicate their shared views on water quality concerns to other governments.

The tribally directed Northwest Indian Fisheries Commission has served as the central body for the participating tribes for coordinating the funding, planning and development efforts in the first phase of the Coordinated Tribal Water Quality Program. Based in Olympia, Washington, the commission was formed in 1974 by the western Washington treaty Indian tribes that were party to *U.S. v. Washington*. Member tribes are Jamestown S'Klallam, Port Gamble S'Klallam, Lower Elwha Klallam, Lummi, Makah, Muckleshoot, Nisqually, Nooksack, Puyallup, Quileute, Quinault, Sauk-Suiattle, Upper Skagit, Skokomish, Squaxin Island, Stillaguamish, Suquamish, Swinomish and Tulalip.

The commission operates on a democratic basis representing the treaty drainage areas of the tribes. Its role is to provide coordination, share information between member tribes and other parties, and provide a unified tribal voice on fisheries management and habitat. The commission maintains a professional staff that provides extensive technical support, public outreach and inter-tribal coordination to member tribes. The commission's constitution provides direction for outreach to non-member tribes as well. Input from non-member tribes is coordinated through the commission's Environmental Policy Committee.

In 1991, in the second phase of the tribal water quality program, the Northwest tribes received funding from the EPA to provide technical coordination to participating tribes for one year. The commission currently employs a water resource coordinator to help render technical services to those tribes requesting assistance in developing and expanding their water quality programs. Through the Coordinated Tribal Water Quality Program, the commission will continue to provide statewide policy coordination, intergovernmental coordination, technical coordination, water quality testing, information management and education services.

Framework Summary:

In summary, the Coordinated Tribal Water Quality Program would operate as follows:

- In all respects it would be tribally directed.
- Each participating tribe would develop its own water quality program through its government-to-government relationships with the EPA, other federal agencies, and state and local governments.
- Neighboring tribes would seek to begin or expand existing comprehensive, cooperative water resource programs with other tribes and with local, state and federal agencies, with particular focus on watershed or regional programs.
- The participating tribes would coordinate their water quality efforts through the Environmental Policy Committee of the Northwest Indian Fisheries Commission.
- The Northwest Indian Fisheries Commission would undertake to provide centralized coordinating and technical service programs for participating tribes and to provide a forum by which participating tribes might arrive at a unified voice on water quality concerns.
- The Coordinated Tribal Program, now just beginning, would develop in stages as funding allows.

Coordinated Tribal Water Quality Program Implementation Schedule:

Full development of the Coordinated Tribal Water Quality Program will occur over four stages. The staging recognizes that not all parts of the program will occur simultaneously with all tribes. Some tribes already have parts of a water quality program in place. Others are just beginning to develop water quality programs.

The circumstances, water quality needs and indirect costs of the tribes vary. Some tribes might choose to use initial program funding for maintaining two water quality staff: One person to be concerned with developing water quality policy and to liaison with other tribes and governments; the other to be a technical field person. Other tribes might choose, depending on circumstance, to use initial funding to support the program needs of one technical field person. Still others might choose to pool their funds in water quality efforts.

Stages In Detail:

Stage I: **Program Development**

Timeline: **September, 1990, to January, 1992**

Funding: **$194,000**

With funding from Congress through the EPA, Stage I has led to the development of the joint program and its strategies, which are the subjects of this report.

Interviews were conducted with policy makers and technical staff at each of the tribes to outline water quality issues affecting reservation and off-reservation waters. The interviews included discussion of tribal activities to combat these problems and on changes in relations with other governmental bodies needed to develop comprehensive, cooperative anti-pollution efforts.

At the beginning of the program tribes could not afford to hire and keep a water quality expert on staff, although hiring and increasing such expertise ranked among the highest tribal priorities.

Stage II: **Providing Minimal Water Quality Infrastructure For Each Tribe And Beginning Statewide Water Quality Coordination Efforts**

Timeline: **September, 1991, to October, 1992**

Funding: **$1,500,000**

While Stage I work began to develop a coordinated tribal water quality plan, participating tribes sought funds from Congress to provide each tribe with enough money to hire or contract for the equivalent of at least one person to begin working specifically on water resource issues.

Congress appropriated $1,500,000 in Fiscal Year 1991 for Stage II purposes. In consultation with the tribes, EPA Region 10 outlined how and for what purposes tribes could seek grants from the $1,500,000 total.

In the summer and fall of 1991, tribes began receiving individual grant approvals from the EPA. Most hired or contracted for their first true water quality staff. Some began expanding water quality programs. Simultaneously, the Northwest Indian Fisheries Commission received EPA funding approval to hire a water resource coordinator and to begin a statewide technical coordination program for tribal water quality programs. While tribes were able to hire water quality staff, the goal of providing infrastructure was not achieved at all 26 tribes because of inadequate funding. Coordination was limited to a minimal level of support.

At the tribal level, the Stage II funding of $1,500,000 to fund minimal water quality programs is allowing individual tribes to begin to inventory, monitor, assess, prioritize and target nonpoint source pollution and other water quality problems within its waters of concern. It also is allowing some tribes to start to update, upgrade or develop water quality standards and water quality programs for achieving those standards for waters within the reservation. This minimal funding, however, only starts the development and implementation of individual tribal programs.

Beyond providing each tribe with minimum water quality infrastructure, Stage II also sets the stage for each tribe to begin to integrate its approaches to particular water quality problems into the overall tribal water quality program. Under Stage II development, tribes began to intensify participation in:

- Cooperative resource management programs involving water quality;
- Statewide coordination of water quality goals, objectives and methods;
- Addressing multi-media issues dealing with water quality;
- Coordinating off- and on-reservation activities and programs; and
- Exploration of alternative cooperative tribal mechanisms for developing and administering on-reservation environmental protection programs.

Stage II also has increased the tribes' ability to participate in water quality processes conducted by federal, state and local governments.

Stage III: **The Coordinated Tribal Water Quality Program**

Development Of Initial Tribal And Statewide Programs:

Timeline: **FY 93**

Funding: **$6,000,000 Per Year**

Tribal policymakers determined that an initial water quality program for each tribe demands funding for the equivalent of two full-time staff. Stage III would provide a basic water quality program for each tribe that could include:

- Continuing the inventorying, monitoring and assessment of waters within its waters of concern;
- Attending technical meetings of water resource staff;
- Having water quality staff and tribal policymakers participate in deliberations of the Environmental Policy Committee; and
- Implementing controls, on a watershed level when possible, on water quality problems.

In addition, individual and neighboring tribes also would undertake with each other and with the EPA, state, municipal and other entities the development of new strategies and agreements to prevent and control nonpoint source and other water pollution on a watershed or regional basis.

These initiatives would include:

- Implementing feasibility studies to develop regional and statewide cooperative water testing laboratories to reduce testing costs and maintain standardized testing methodologies;

- Developing a centralized water quality database to be shared by all tribes and other entities;

- Developing an educational program on how to prevent and stop water pollution, especially nonpoint source pollution. The program would also acquaint Indian and non-Indian people of tribal efforts to combat water pollution and why clean water is so important to the tribes;

- Continuing to disseminate water quality information quickly and uniformly among tribes; and

- Helping tribes coordinate their activities with national Indian organizations.

Developing water testing laboratories and data management programs would carry high front-end planning and equipment costs. Developing and beginning to operate all of these centralized programs would require additional staff.

Individual Tribal Programs And Implementation Of Cooperative Programs:

In Stage III the individual tribes would continue to develop, maintain and implement their basic water quality programs. All tribes intend to have water quality standards and water quality programs enacted into ordinances and regulations in this phase. In addition, with the experience of several years of developing water quality programs and with basic water quality staff in place, tribes sharing watersheds and/or treaty or other rights concerning the same waters would undertake to develop, formalize and implement joint intertribal water quality programs.

Such cooperative developments among tribes will not necessarily all occur at the same time. The tribes involved in the Skagit System Cooperative, Point No Point Treaty Council and Upper Columbia United Tribes organization, to some degree, already have developed joint water resource efforts. Many other tribes, the Stillaguamish and the Tulalip for instance, have enjoyed long working relations with each other on water matters affecting shared drainages.

It will be in this point of Stage III, however, that the participating tribes would devote concentrated effort to bring about closer cooperation among themselves in given watersheds or management areas. This effort will require considerable discussion and formal planning.

To take advantage of cost savings and the multiplied positive effects of regional programs, such regional opportunities could include:

- Development of watershed, regional and statewide intertribal water pollution response plans and teams, especially for dealing with oil spills;

- Development of staff expertise to use on a watershed or regional basis;

- Development of specific watershed or regional water quality plans; and

- Development of watershed or regional water-testing laboratories.

Intimately connected and complementary to such tribal efforts would be tribal undertakings to expand or initiate joint watershed and regional water quality programs with federal, state and local governments and other entities. Many tribes already are involved in such watershed programs with other governments. In this point of Stage III, the participating tribes would reach out to further expand and develop such programs.

To develop, implement and maintain such programs requires constant effort and expense. Stage III funding is intended, among other things, to provide participating tribes with the resources to match their governmental neighbors in the ability to share common expenses. In addition, through the Northwest Indian Fisheries Commission, participating tribes would undertake full-scale implementation of centralized water testing laboratory, data management, educational and public relations programs necessary to successful functioning of the Coordinated Tribal Water Quality Program. The tribes also would begin to explore development of standards to prioritize funding for special individual and multi-tribal water quality projects.

The Coordinated Tribal Water Quality Program And Water Quality Education:

At this point in Stage III, all of the individual, cooperative and centralized programs developed and put into effect during previous stages would be operating. The Coordinated Tribal Water Quality Program would not be static, however. Many individual tribes would have moved from a basic water quality program involving two full-time-equivalent staff to expanded programs requiring more expertise and therefore more hired or contracted staff. Because of differing needs among tribes, no single generalization can capture the extent of this program building.

Anyone aware of the water quality problems in the State of Washington knows that the tribes, as well as the federal, state, county, municipal and other governments, face a control, clean-up and remediation task that will take years and millions of dollars to accomplish. In addition, the tribes and other governments face the prospect of decreased water quality from ever more population crowding into the Puget Sound Basin and other areas already heavily affected by the water quality problems attendant to growth and development.

It is impossible at this point in the development of the Coordinated Tribal Water Quality Program to anticipate and prescribe for all of the water quality problems the tribes and other governments might face. To try to allay the impacts of growth and development, the participating tribes would seek to extend one sure tool in the struggle against water pollution: Education.

The tribes would expect to have a centralized water quality education program to help instruct tribal and neighboring publics about water pollution and efforts by the tribes and others to curb and remediate it. Here the tribes would propose to carry that educational program a major step forward in conjunction with the Northwest Indian Fisheries Commission and appropriate federal, state and local agencies. Together they would develop a water quality education program for curriculums from kindergarten to college.

Also, as part of a process to educate their own and other water quality managers, the tribes would begin to plan with federal, state and local and private entities a new, major water quality watershed demonstration project. The project would aim to show that focused, funded, concerted, cooperative effort will slice through delay and confusion to bring about quick, needed restoration of water quality. Such a cooperative demonstration project, which could serve as a national model, would take considerable effort, money and time to plan.

As a way to help build and deepen the spirit of cooperation with other entities, participating tribes in also would like to begin an exchange program between tribal water quality staff and state, county, municipal and private water quality staff. This approach would build a solid understanding of the issues and limitations faced by one another.

Stage IV: **The Coordinated Tribal Water Quality Program Including Demonstration Projects**

Timeline: **FY 94**

Cost: **$10,000,000 (estimated)**

$6,000,000 to continue initiatieves developed in Stage III plus $4,000,000 for demonstration projects

Along with maintaining and building the functioning tribal programs already described, in Stage IV of the Coordinated Tribal Water Quality Program the participating tribes would want to contribute their share to implementing the educational, demonstration and exchange programs developed earlier. They would want to be especially sure that the demonstration project is adequately funded to carry it through to a successful conclusion.

In Stage IV the tribes also would seek to fund special projects arising out of the particular needs of one or more tribes. One aim is to sustain tribally created programs that not only would meet a water quality problem but would also serve as a model for efforts by other tribes.

Finally, as part of the activities in the demonstration projects, the participating tribes would hope to secure funding that could be used for grants. These grants would stimulate and sustain efforts by non-tribal governments in working with the tribes to deal with water quality and water quantity. The tribes see such grants as a way of showing that individually and as partners in the Coordinated Water Quality Program, the tribes are serious about engaging other jurisdictions in comprehensive, cooperative, coordinated efforts to deal with water quality and other problems.

After maintaining the general tribal programs, watershed deomonstration projects would require an additional $4,000,000. Actual costs will be more accurately estimated when demonstration projects are selected. This is an initial conservative estimate based on preliminary knowledge of program/project needs.

The demonstration projects will be designed to demonstrate tribal capabilities and access funding sources for ongoing tribal projects. Future funding would be determined by need and financed through existing EPA funds.

The outputs for each stage of the Coordinated Tribal Water Quality Program are summarized in the following chart:

Staging Within the Coordinated Tribal Water Quality Program

FUNCTION AND TASK	STAGE II	STAGE III	STAGE IV
Costs:	$1,500,000	$6,000,000	$10,000,000
TRIBAL GOVERNMENTS:			
Minimal Water Quality Program	X		
Basic Water Quality Program		X	X
Tribal Policy-Making	X	X	X
Intergovernmental Relations		X	X
Water Quality Monitoring and/or Assessment		X	X
Educational Programs		X	X
WATERSHED/REGIONAL COORDINATION			
Skagit System Cooperative		X	X
Point No Point Treaty Council		X	X
Upper Columbia United Tribes		X	X
Nooksack Drainage		X	X
Stillaguamish & Snohomish Drainages		X	X
King County and the Kitsap Peninsula		X	X
South Puget Sound Drainages		X	X
Olympic Peninsula Coastal Drainages		X	X
Central Columbia River Drainages (Yakima Indian Nation and other affected tribes.)		X	X
Chehalis Drainage		X	X
The Willapa Bay Drainages		X	X
STATEWIDE COORDINATION:			
Policy Coordination	X	X	X
Intergovernmental Coordination	X	X	X
TECHNICAL COORDINATION:			
Water Quality Testing		X	X
Data Information Management		X	X
Education-Tribal Programs		X	X
Education-State School Programs			X
Intertribal Coordination	X	X	X
National Coordination		X	X
SPECIAL PROJECTS:			
Model Watershed Projects			X
Staff Exchanges			X

Appendix A

Coordinated Tribal Water Quality Program Accomplishments: FY 91

Following is a list of tribal accomplishments during Fiscal Year 1991 of the Coordinated Tribal Water Quality Program.

The Coordinated Tribal Water Quality Program is designed to allow the tribes to address water quality issues affecting their reservation lands and treaty protected resources. The program is designed to create individual, tribally-directed programs as part of a statewide coordinated program.

In addition to the individual tribal program accomplishments outlined below, the tribes worked as a whole at both technical and policy levels in the development and early implementation efforts of the program.

Some of those accomplishments included:

- Technical coordination on the compilation of information regarding current water quality issues and program needs.
- Policy decisions on program content and direction.
- Integration of the Coordinated Tribal Water Quality Program into the tribal strategy to manage treaty protected resources.
- Development of support statements from individual tribal governments for the Coordinated Tribal Water Quality Program.

Sauk River near the Sauk-Suiattle Tribe Reservation.

Colville Confederated Tribes:

- Hired a Database Manager (tribal member).
- Updated Water Resource Database into an Arc/Info System. Once on-line it will be immediately available to approximately 100 resource managers. This information management system is designed to be shared with land managers, decisionmakers, landowners, and used in technical processes such as nonpoint source assessments and water quality monitoring. The system was designed to be a transferrable demonstration type project.

Hoh Tribe:

- Purchased water quality investigation equipment.
- Conducted an in-depth water temperature study of eight streams within the tribe's area of concern to analyze the effects of logging on water temperature. The study will be incorporated into the Sensitive Issues Action Plan for the Hoh River basin, an inter-agency resource management plan. The Washington State Department of Ecology (DOE), Department of Natural Resources (DNR), Department of Fisheries (WDF), Washington Environmental Council (WEC), and the Hoh Tribe are cooperators in this plan. The study utilizes thermal pollution standards developed by EPA.

Jamestown S'Klallam Tribe:

- Staff Reorganization: Existing staff was assigned to water resources issues. New staff was hired to backfill previous assignments in fisheries management.
- PIE Grant: The tribe secured a $20,000 Public Involvement and Education grant from the Puget Sound Water Quality Authority to prepare educational materials for a "State of the Dungeness River" presentation.
- Participation on Community Watershed Planning and Growth Management Committees: The tribe has actively participated on the Sequim and Dungeness Watershed Management committees and the Clallam County Critical Areas Committee.
- Dungeness/Quilcene Water Resources Pilot Project: The tribe successfully nominated the Dungeness/Northeast Olympic Peninsula region as a water resource pilot project under the Chelan Agreement. Using a combination of EPA and DOE support, the tribe has acted as the interim coordinating entity for the project on behalf of the two tribes, two counties, two cities and two utility districts.
- The tribe is coordinating with the Point No Point Treaty Council on two planning efforts that will assist in development of a water quality work plan for the Jamestown S'Klallam Primary Area. The first project, funded through the state Centennial Clean Water Fund, involves water quality monitoring in the Point No Point Treaty Area. The second project is being conducted as part of the implementation of the Strait of Juan de Fuca Management Plan. As part of this effort, the tribe is developing water quality and fisheries habitat profiles for each Strait of Juan de Fuca tributary. The profiles will outline habitat conditions, problem areas and potential actions.

Lower Elwha Klallam Tribe:

- Hired Water Quality Technician, increased the number of tribal staff working on water quality issues, and created a tribal Water Quality Office.
- Identified existing tribal resources; conducted needs assessments and review of reservation watersheds.
- Assisted in establishing a public environmental education program.
- Assisted in establishing the Adopt-A-Stream program within the tribal Summer and After School Program.
- Completed Phase I of a drinking water survey and conducted several water supply workshops for tribal members.
- Worked to establish a Comprehensive Watershed Monitoring Plan.

Lummi Tribe:

- Collected Nooksack River Basin data sources on water quality hydrology and drainage; conducting analysis of man-made modifications and quality to flow.
- Identified and conducted initial assessment of reservation water resources; drainage and groundwater studies underway.
- Draft water code under review, initial work begun to develop reservation infrastructure including water quality standards.

Verne Johnson, Lummi Tribe Environmental Policy Representative, examines a water sample.

- ARC/Info System in place and operating. A Geographic Information Specialist was hired and currently is working on application of state Department of Natural Resources (DNR) data.
- Acquired spatial coverages for streams, wetlands and anadromous fish resources for the tribe's Geographic Information System (GIS) database.

Makah Tribe:

- Hired Senior Water Resources Planner.
- Developing an existing conditions section of a sewage treatment plant siting plan.

- Working on a restructuring of the planning department to accommodate growth and development, including water quality issues such as permitting.

Muckleshoot Tribe:

- Hired full-time Water Quality Program Planner to begin developing Water Quality Environmental Protection Project.
- Developing comment letters on issues threatening tribal waters of concern.
- Active participation in the adoption of the Soos Creek Community Plan.
- Developing a threat assessment of issues affecting tribal waters of concern.
- Analysis of federal, state, local and tribal framework in which the tribe must function, including regulatory, jurisdictional and planning processes relative to water resource issues.

Nisqually Tribe:

- Developed Ambient Water Quality Monitoring Program for Nisqually River basin, with stations on the Nisqually River and five tributaries. Three cooperating agencies have been identified.
- Initiated collection of water quality data from 11 monitoring stations, established three gauges to measure in-stream flow and, as a cooperator, one new U.S. Geological Survey (USGS) gauge.
- Developed water resources committee for Nisqually River Council; provided staff coordination for the committee.
- Initiated assessment of water quality problems both on- and off-reservation; developing approaches to address problems.
- Developed and submitted to DOE a $250,000 Centennial Clean Water Act grant application for nonpoint pollution investigation on two tributaries.

Nooksack Tribe:

- Established a water quality literature loan library and reading desk for tribal reference.
- Began educational outreach to schools and organizations on tribal water quality issues.
- Coordinated regulatory design with local governments on water quality components of Growth Management Planning Act documents.

- Briefed tribal council and inter-tribal policy personnel on priority water quality issues and long-term planning.
- Assembled data and constructed initial files for long-term water quality program development.

Port Gamble S'Klallam Tribe:

- Hired an Environmental Program Director to address water quality concerns of the tribe.
- Developed a political, social, and regulatory approach to water quality protection on the tribe's area of interest.
- Participated on Hood Canal Coordinating Council (composed of three counties and two tribes) and cooperative water quality efforts on Hood Canal.
- Participating, and regularly meeting with 12 environmental and community groups to increase effectiveness in addressing local water quality concerns.
- Developing on-reservation water quality standards to address forestry and land-use issues.

Puyallup Tribe:

- Hired an additional Water Quality Technician to build tribal expertise and to assist in the development of the Puyallup Tribal Water Quality Management Program.
- Continued development of Puyallup Tribal Water Quality Management Program.
- Began initial assessment of Puyallup River system.
- Began initial water quality assessments of Midnight and Slide creeks (at confluence with the Greenwater River) to implement fisheries enhancement projects.

Quileute Tribe:

- Hired Environmental Policy Analyst and a Water Resources Biologist.
- Started water resource planning for the 640-square mile Bogachiel watershed. Effort includes water quality and fisheries habitat studies.

Quinault Tribe:

- Developed contract with the University of Washington to take four sediment core samples at Lake Quinault to determine productivity changes in the lake. The samples are scheduled to be taken in late March 1992.

- Established the full-time position of Freshwater Ecologist in the tribe's Fisheries Division.
- Assigned the Fisheries Division Deputy Division Officer as the interim point of contact for EPA grant-related water quality activities to ensure continuity until such time as the Freshwater Ecologist assumes responsibility for the task.

Skagit System Cooperative (SSC)
Swinomish, Upper Skagit and Sauk-Suiattle tribes:

- Established a water quality task list with specific program descriptions and time lines from July 1991 through June 1992.
- Completed a comprehensive review of historical water quality data for the SSC area of interest. Submitted review in report format to identify known problem areas and un-monitored areas, both freshwater and marine.
- Conducting a data review addressing water quality issues of concern in SSC area of interest.
- Arranged and participated in government-to-government meetings with Skagit County commissioners to present tribal off-reservation issues of concern in SSC area of interest.
- Actively participating with local county planning department on policy and technical levels concerning local nonpoint source pollution issues.

Skokomish Tribe:

- Filled position to perform and coordinate water quality activities.
- Hired a half-time Water Quality Technician
- Divided water quality program into surface and groundwater areas; set up monitoring program for both areas to develop baseline information.
- Purchased water quality equipment and lab services.
- Comparing monitoring data regarding surface and drinking water with past USGS data to assess water quality trends.
- Developing groundwater data to substantiate environmental/health needs, such as wastewater treatment and drinking water.
- Implementing the Skokomish Environmental Protection Act.
- Developing an integrated flood management plan with Mason County and Washington state.

Squaxin Island Tribe:

- Established full-time Water Resource Planner position in tribal Natural Resources Department.
- Program framework has been developed and written for the tribe's water quality program.
- Initiated organizational and coordination meetings between the tribe's on-reservation planners and habitat biologists.
- Active participation on local watershed councils and other water quality and land-use planning processes has been maintain through out the tribe's area of interest.

Stillaguamish Tribe:

- Compiling information on land-use in the Stillaguamish watershed. Land-use directly affects water quality and quantity in the Stillaguamish basin. Information on land-use within the watershed is scattered among many departments in county government, with no central location for the information. The tribe is beginning to compile this information, enter it into a database and begin mapping all land-uses within the watershed. The data will eventually be entered into a GIS. This information will be used to give a detailed description of land allocation within the river system and indicate where problems with water quality could be occurring.
- The tribe is working in conjunction with the Tulalip Tribes to begin water quality monitoring on the north and south fork of the Stillaguamish River. The tribe is awaiting the completion of water quality lab facilities, which should be completed by March 20, 1992.
- Completed on-reservation water conservation project that included installation of low-flow toilets, faucet aerators and low-flow shower heads.
- Establishing database of all water rights applied for and/or granted in the Stillaguamish basin.
- Compiled all well logs that pertain to the watershed. Will be entering logs into a database. The logs show public systems with fewer than six connections. Those with more than six connections should be indicated on water rights application.
- Recorded water rights have been plotted on maps. These show withdrawal type (irrigation, domestic, etc.) and indicate study sites that would be affected during serious drawdown.

Suquamish Tribe:

- Continued participation on Sinclair Inlet Watershed Management Committee.
- Participation on Foss Creek Comprehensive Management Plan steering committee.

- Participated with DOE on a tour of the Puget Sound Naval Shipyard to review the approximately 100 stormwater outfalls.
- Continued participation as chair of Kitsap County's Solid Waste Advisory Committee.
- Continued review of Superfund documents relating to Naval Submarine Base Bangor.

Richard Miller, Tulalip Tribes Water Quality Technician, records dissolved oxygen levels in Quilceda Creek.

Tulalip Tribes:

- Hired an Environmental Program Analyst.
- Developed scope of work for the tribal water quality program.
- Designed Phase I Study: Water Quality Data Review; Currently implementing the study.

Upper Columbia United Tribes (UCUT) Spokane and Kalispel tribes:

- Water quality program contract with the Kalispel and Spokane tribes was signed and subcontracted to UCUT on March 1, 1992. The limnologist/hydrologist position for this contract will begin on April 1, 1992.

Yakima Indian Nation:

- Established a full-time position for a hydrologist to work on off-reservation issues. Hiring for this position is in process.
- Increased participation in development of Yakima River Basin Water Quality Plan, which covers an area that lies totally within the Yakima Ceded Area and includes reservation lands.

Northwest Indian Fisheries Commission:

- Developed consensus-based regulatory rules to address cumulative impacts to fish and water quality as a result of forest practices on state and private lands.
- Coordinated state/tribal and federal/tribal meetings to address water quality issues and to help facilitate implementation of the Coordinated Tribal Water Quality Program.
- Coordinated inter-tribal meetings to help facilitate implementation of the Coordinated Tribal Water Quality Program.

Appendix B

Excerpts From The United States Of America National Report To The United Nations Conference On Environment And Development

The United States produced this report as part of the preparations for the United Nations Conference on Environment and Development to be held in Brazil in June 1992.

"One of the most comprehensive and successful examples of tribal/state/federal cooperation in resource management is the management of salmon resources in the state of Washington. Tribal fishing rights guaranteed by treaty are found in a series of treaties negotiated in the 1850s by Territorial Governor Isaac Stevens with a number of tribes in the Northwest. These Indian fishing rights were ignored in the settlement and development of the region, leading tribes to seek redress in the courts.
"Fisheries management in the area was changed fundamentally in 1974 when Judge George Boldt issued his ruling in U.S. v. Washington. In this decision, Indian treaty fishing rights were reaffirmed and tribes were established as co-managers of the resource. Legal battles with the state of Washington continued into the 1980s, however, as a the salmon fishery resource continued to decline. By default, fishery management fell to the court, with state and tribal biologists constantly at odds. It was soon apparent to all parties that if the fish resource was of primary concern, the job of managing it must be removed from the hands of the court and placed back into the hands of professional tribal and state managers.

"In 1985 a tribal/state plan for cooperative management of fisheries in Puget Sound was jointly developed and approved by the federal court under U.S. v. Washington. Today, litigation over fisheries is the exception rather than the rule in managing this key resource.

"The tribal contribution to this partnership is substantial. In 1976, tribal hatchery releases for the 20 treaty tribes who are members of the Northwest Indian Fisheries Commission (NWIFC) in the state of Washington totalled 9,929,000 fish. In 1990, the tribal release totalled 42,779,000 fish. In addition, tribal biologists participate in all facets of fishery management and are expanding their efforts into broader water quality programs as well. This is reflected in the 1990 Lake Chelan agreement for comprehensive water resources management, and in the non-point source pollution control project currently being conducted by the NWIFC in cooperation with state and local governments, with funding from the U.S. Environmental Protection Agency."

***

"...In addition, tribes that meet requirements under U.S. Environmental Protection Agency (EPA) regulations may receive primary enforcement authority for program functions and join with EPA as partners to ensure effective compliance with federal environmental laws. Under this program, tribes may establish environmental management codes and regulations, issue federally enforceable permits, and join with the federal government in taking appropriate enforcement actions. These partnerships are similar to those that state governments are eligible to develop with the federal government."

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COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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Fax (503) 235-4228

March 19, 1993

The Hon. Elizabeth Furse, Member of Congress
316 Cannon Building
U.S. House of Representatives
Washington, D.C. 20515

RE: Written testimony concerning salmon restoration through habitat protection and hatchery reforms relevant to the Committee on Merchant Marine and Fisheries, Subcommittee on Environment and Natural Resources, Hearing on the Roles Watershed Management and Hatchery Practices will play in the Restoration of River Ecosystems in the Pacific Northwest, March 9, 1993.

Dear Rep. Furse:

Pursuant to your request of March 15, 1993, to Mr. Ted Strong, Columbia River Inter-Tribal Fish Commission (CRITFC) Executive Director, I am submitting the following comments on the testimony presented to the Subcommittee on March 9. I have asked my colleague, Mr. Jon Rhodes, a hydrologist and expert on habitat protection, to join me in these comments so that the Subcommittee would have access to Mr. Rhodes' perspectives on the importance of habitat protection, and the benefit of some highly specific information on the role of habitat protection in salmon restoration. We open with comments on hatchery reforms, followed by a discussion of the importance of habitat protection. We conclude with specific recommendations for habitat protection actions that can be taken on federal and private lands.

The Need for Hatchery Reform

In concert with all the members of the scientific panel, we agree that hatchery technology has a role to play in the restoration of river ecosystems in the Pacific Northwest. We also agree with Dr. Kapuscinski that hatchery reforms are essential in order for hatchery technology to play an effective and positive role in recovery of Columbia basin salmon populations. In the Columbia River basin and elsewhere, state and federal agencies have used federal money for hatcheries to raise the wrong species and stocks of salmon with the wrong technology and released them in the wrong locations for too many years. Hatchery reform is necessary so that technologies can be applied to restore, and to maintain for as long as necessary, the biological and genetic diversity of salmon in the Columbia River basin. Hatchery reform is necessary to restore the historical species composition of salmon to the localities where they were once locally abundant. Hatchery

reform entails relocating points of hatchery releases, re-designing and re-directing the fish culture technologies, and increasing both the number of species and life history types of salmon that are protected within hatchery programs. In his testimony, Dr. Koenings provided a good overview of how proper supplementation can aid in restoring salmon populations.

Our Columbia River perspective is different from that of panel member, Mr. Higgins, of California, in that we do not believe that salmon restoration is possible without reformed hatchery programs to sustain salmon stocks until the their habitats can recover. We know that at least 65 populations of salmon have been extirpated from their habitat in the Columbia River basin above Bonneville Dam and another 32 populations have been sharply declining for 15 or more years (CRITFC, 1992). Too many salmon populations have been extirpated over the years when no hatchery programs were put into place to preserve them. Snake River basin coho salmon, upriver chum salmon, and sockeye salmon have been totally lost due to the lack of any hatchery, or other aquaculture, programs to incorporate and preserve their genetic materials. In contrast, Snake River fall chinook salmon, and spring chinook from above the Hell's Canyon Dam complex have been saved from extirpation by hatchery programs. In the history of the Columbia River basin, wherever hatchery programs have been denied, genetic material from salmon populations in the area has been irretrievably lost. Thus, our experience dictates that the risks to salmon recovery of neglecting hatcheries are far greater than risks incurred by applying these technologies.

Our practical experiences, and those of the CRITFC member tribes, in selecting and applying appropriate technologies to salmon recovery are reflected in a large volume of documents which we and other tribal technical employees have produced over the years. These include: Subbasin Plans, Integrated System Plan, Salmon Recovery Proposal for the Columbia Basin, Upper Grande Ronde River Anadromous Fish Habitat Protection and Restoration Plan, numerous analyses of forest management plans, Regional Assessment of Supplementation, Integrated Tribal Production Plan Volume 1: Snake River, Yakima Basin Fisheries Master Plan, the Nez Perce Tribal Hatchery Master Plan, and the Genetic Risk Assessment for the Hood River Basin, among others (for copies of any of these documents, please contact Roberta Stone, Ray Hecocta, or Sandra Petersen, 503-238-0667). As pointed out by a number of panel members, restoration technologies need to be evaluated on a case-by-case basis in each watershed; no single hatchery technology could be appropriate for all cases.

Of course, we strongly agree with all the members of both the Watershed Management and Hatchery Panels that habitat restoration and protection are essential to long-term recovery of salmon and their ecosystems. The CRITFC member tribes, as proprietors of fisheries resources, have a long history of working with all other governments and other concerned entities to manage natural resources in a sustainable fashion. In particular, the tribes have identified watershed management as an important tool for salmon recovery. Watersheds are the building blocks of the ecosystem, and the ecosystem must be healed, and kept whole, for the salmon to recover.

We agree with the panels that the role of the federal government is to unite Columbia basin watershed management plans under principles that permit recovery of the ecosystem at a reasonable pace, while respecting the interests of the stakeholders in each watershed. We caution that recovery of the ecosystem must not, however, continue to be sacrificed to special interests.

The activities of all governmental and private entities must be aligned and coordinated to effect recovery. All government agencies must have missions that are compatible with the restoration of river ecosystems. In this regard we recommend a broad ecosystem initiative based on watershed protection and restoration that would inform the public about their dependence on the resource, and that would integrate biological, social and cultural values. Such a comprehensive approach is essential to replace existing government programs now aimed at salmon recovery which are too narrowly conceived and imperfectly implemented to be of much help.

We point out that comprehensive restoration programs are essential to align policies of federal land management agencies to protect key habitats. Such restoration programs could work by developing landscape-wide riparian protections, among other measures proposed by panel members on March 9. In order to be effective, these programs must have evaluation criteria that focus on measures of the health of the watershed, along with incentives for cooperation of private land owners.

The Importance of Habitat Protection

As scientists, we know that suitable and sufficient natal habitat is a critical to restoring naturally reproducing fish stocks. Unfortunately, non-point source pollution generated by land uses such as tilled agriculture, grazing, logging, road construction and mining have already significantly degraded extensive portions of the spawning and rearing habitat throughout much of the Columbia basin (Theurer et al., 1985; Platts et al., 1989; IDHW, 1989; ODEQ, 1989; NPPC, 1990a; NPPC, 1990b; NPPC, 1990c; CRITFC, 1991a; CRITFC, 1991b). Available data consistently indicate that the degradation of natal habitat has severely reduced the survival of the few salmon that successfully run the hydroelectric gauntlet. In concert with the high levels of mortality at Columbia basin hydroelectric facilities, the reduced survival in degraded natal salmon habitat has fostered the dramatic declines in salmon and other fish populations throughout the Columbia over the past five decades. There is a pressing need not only to protect habitat from further degradation, but also to take measures that will allow salmon habitat to recover naturally to the point where salmon survival is, once again, at levels conducive to rebuilding the salmon runs. Very little high quality habitat remains. Protection of the remaining high quality habitat must be a priority. We know that habitat protection is far more effective and inexpensive than habitat restoration.

Habitat degradation is a pervasive problem in the Columbia. Outside of wilderness and roadless areas, riparian areas are in poor condition. Most "managed" watersheds retain only a fraction of their original natural functions as the degraded conditions of fish habitat, water quality and fish populations grimly attest. It is abundantly clear that the mere maintenance of the current degraded status of salmon habitat will hamper or defeat efforts to rebuild the salmon runs. In fact, if existing conditions are maintained, it is probable that salmon and resident fish populations will continue to dramatically decline and ultimately disappear from many streams throughout the Pacific Northwest. Unfortunately, over most of the Columbia basin, management aimed at habitat restoration and protection is not even on the horizon. There are very few watersheds that are currently in recovery mode, yet degradation of fish habitat continues on an vast scale.

While there is a constant need to improve the information base for habitat management decisions, enough is currently known to better protect fish habitat and water quality. These measures must be implemented immediately because although watersheds and fish habitat can recover naturally from degradation, the impacts are long lasting. Full ecological recovery of degraded habitat requires approximately 25 to 200 years depending on the type of the impact (Gregory and Ashkenas, 1990). However, damaged habitat can never recover unless the causes of the degradation are arrested. Unfortunately, the needed protection and restoration measures are not yet in place within any regulatory framework.

Healthy riparian areas are critical to the maintenance of productive fish habitat. The importance of riparian vegetation to fish production cannot be overemphasized. Riparian vegetation provides stream shading to keep streams cool, filters sediment from upslope sources, stabilizes stream banks, and provides the large woody debris that forms the large pools and complex physical structure needed by anadromous fish throughout their freshwater life stages. Impacts to riparian vegetation are not consistent with either the maintenance or improvement of fish habitat. If riparian areas are not protected, salmon populations cannot be protected or restored. Unfortunately, riparian vegetation along natal salmon habitat does not currently receive adequate protection under any land ownership in the Columbia basin outside of wilderness and roadless areas. The greatest degradation of fish habitat in the Columbia basin is generally caused by removal of riparian vegetation by livestock grazing, road construction, mining, logging, and tilled agriculture (Theurer et al., 1985; IDHW, 1989; ODEQ, 1989; Platts et al., 1989; NPPC, 1990a; NPPC, 1990b; NPPC, 1990c; CRITFC, 1991a; CRITFC, 1991b). This degradation has caused or resulted in chronic sedimentation, elevated summer water temperatures that are lethal to salmon, and huge losses in large woody debris and pools. Data consistently indicate that in poor habitat salmon mortality is about 10 times higher than in less degraded habitat, regardless of how few salmon make it into the habitat.

While riparian protection is critical to the protection and restoration of the salmon habitat, it is not a panacea for avoiding habitat damage caused by upland impacts. Mining, grazing, logging, road construction, and tilled agriculture outside of riparian areas still deliver significant amounts of non-point pollution to fish habitat. Sediment is the dominant pollutant contributed from these sources; however, mines also contribute considerable chemical pollution and, in many cases, render salmon habitat unusable (NPPC, 1990c; Nelson et al., 1991).

The catastrophic sedimentation of the South Fork of the Salmon River provides a well-documented example of the effect of habitat degradation caused by land disturbance at the watershed scale and its effect on salmon. The sedimentation of the South Fork of the Salmon River was primarily caused by logging-related land disturbance (IDHW, 1991). The sedimentation caused catastrophic declines in salmon and resident trout populations in the South Fork of the Salmon River which had once been the most fecund summer chinook salmon habitat in the entire Columbia basin (Platts et al., 1989). Summer chinook salmon runs in the South Fork of the Salmon River dwindled from more than 10,000 fish to mere hundreds, after the catastrophic sedimentation event. The summer chinook salmon of the South Fork of the Salmon River are now listed as "threatened" under the Endangered Species Act.

Recommendations on Habitat Protection Actions

1. **Federal Lands.** Lands under United States Forest Service (USFS) ownership provide approximately 50-70% of the remaining spawning and rearing habitat in the Columbia basin (Sedell and Everest, 1990). Therefore, it is critical that the USFS provide adequate protection for these habitats, if salmon populations are to be restored. Unfortunately, Forest Plans for the Columbia basin forests will cause more, not less, habitat degradation. Under every Forest Plan, there will be an increase in road mileage and watershed disturbance that will cause increased sedimentation. Every plan also calls for continued logging, grazing, mining, and road construction in riparian zones. Recent evaluations of some Forest Plans by the USFS's own scientists, at the behest of Congress, indicate that there is a very low likelihood of continued viability of depressed populations of salmon and resident fish if these Forest Plans are fully implemented (Johnson et al., 1991). Our own analysis of the Forest Plans concluded similarly that degradation of fish habitat would be severe under all of the Forest Plans. Accordingly, the memeber tribes of CRITFC were put in the unfortunate and undesirable position of having to file administrative appeals of 15 Forest Plans in the Columbia basin in an effort to improve the protection for fish habitat.

At least four credible and scientifically developed management scenarios for protecting salmon habitat in the Columbia basin already exist. These are: 1) the South Fork of the Salmon River Step Plan (Payette National Forest, 1987); 2) the components of land management evaluated by Johnson et al. (1991) as necessary for a high likelihood of continued viability of fish populations; 3) the Upper Grande Ronde River, Fish Habitat Protection, Restoration, and Monitoring Plan (UGRRMP); 4) CRITFC's technical recommendations for the management of critical spawning and rearing habitat in the Snake basin (CRITFC, 1991b). Notably, all four habitat management scenarios contain similar components, indicating that there is a great deal of consensus among the scientific community. We strongly recommend that Bureau of Land Management (BLM) and USFS land management plans for the Columbia basin be immediately amended to incorporate the provisions contained in these four approaches to protecting fish habitat.

The components recommended by Johnson et al. (1991) include: 1) a system of reserve watersheds with high-valued fish production that are not to be roaded and logged; 2) the elimination of riparian zone logging; 3) an aggressive program to remove riparian roads and reduce the road mileage in all watersheds; 4) a program to improve road drainage; 5) the use of low impact logging systems such as helicopter logging; and 6) an increase in the rotation length of timber harvest. Although the report by Johnson et al. (1991) is now almost two years old, the USFS has failed to adopt any of the recommendations.

Similar to the provisions of Johnson et al. (1991), the UGRRMP calls for complete riparian zone protection, an aggressive program of road obliteration and road improvement, full protection of existing roadless areas, and short term elimination of grazing in degraded riparian zones. The UGRRMP also sets performance standards for fish habitat components; until the standards are met, further impacts to the watershed are prohibited. The UGRRMP also calls for rigorous monitoring of fish habitat conditions and usage.

CRITFC's recommendations for the management of critical habitat in the Snake River basin (CRITFC, 1991b) which include: 1) elimination of riparian zone impacts; 2) an aggressive road obliteration program; 3) revision of all grazing allotments in the Snake basin; 4) limitations the frequency, intensity, and amount of land disturbance in watersheds; and 5) the elimination of grazing on degraded riparian areas until full ecological recovery has occurred.

The South Fork of the Salmon River Step Plan placed a moratorium on all land disturbance within the degraded watershed. The moratorium is to remain in effect until stream sediment standards in fish habitat are met. The South Fork of the Salmon River Step Plan also developed a program of sediment reduction through road obliteration. Notably, the South Fork of the Salmon River Step Plan is the only one of the four approaches that has been implemented. It is also the only degraded stream in the Columbia basin that has been documented to have improved over the past 25 years. The EPA has now officially adopted the South Fork of the Salmon River Step provision as the primary means of implementing the Clean Water Act Provisions for streams that have been identified as "Water Quality Limited."

The message that is common to all four of these approaches is that protection of salmon habitat and populations requires that we limit watershed disturbance (logging, grazing, mining and road construction) and eliminate the degradation of riparian vegetation. We agree with the testimony of the panel that these principles must be the cornerstones of comprehensive watershed management aimed at restoring salmon populations.

2. State and Private Lands. The states of Idaho, Oregon, and Washington have failed to control non-point source pollution and enforce their water quality standards developed under the Clean Water Act (CRITFC, 1991a). These states have also failed to develop water quality standards that fully protect fish habitat. In tandem, this has allowed severe degradation of fish habitat on federal and private lands. Most of the problems existing in fish habitat are attributable to the failure of regulatory agencies to enforce the Clean Water Act.

The Forest Practices Rules in Idaho, Washington, and Oregon are inadequate to fully protect salmon habitat. At a minimum, these Forest Practices Rules will have to be amended to require full protection of riparian vegetation, if salmon populations are to be protected and restored.

The states should begin to fully enforce existing water quality standards and immediately develop Total Maximum Daily Loads for streams that have been identified as "Water Quality Limited" under the Clean Water Act. The state water quality authorities should also rigorously review existing data and identify all streams as "Water Quality Limited" where existing water quality standards are not being met and the beneficial use of the water by anadromous fish is impaired. The water quality agencies should also immediately develop and adopt water quality standards that are biologically based, and that are designed to fully protect fish habitat. These agencies should also develop and adopt mandatory management practices for agriculture and mining.

The states also need to analyze water right applications for their effect on fish habitat

production capability. The states should cease issuing permits for water withdrawals that adversely affect the production potential of fish habitat. Instream flows have been significantly reduced on thousands of miles of salmon-bearing streams; hundreds more miles of streams have been completely de-watered.

Conclusion

Hatchery production and habitat protection and restoration can and should play complementary roles in restoring the salmon populations of the Columbia basin. We agree with the scientific panel's testimony that current hatchery and land management practices both need to be immediately reformed to incorporate our existing knowledge so that we can restore the Columbia basin salmon populations before more salmon stocks are lost. The science is available to accomplish the reforms. It is solely a matter of using the best scientific information available and implementing readily available plans that have been based on this information.

If you or the Subcommittee needs any additional information or has any further questions, we stand ready to provide assistance.

Thank you for the opportunity to comment.

Sincerely,

Dale A. McCullough, Ph.D. -for-

Phillip R. Mundy, Ph.D., Manager
Fisheries Science Department

Jon Rhodes, M.S., Hydrologist
Fisheries Science Department

Attachment: List of Literature Cited

Literature Cited

(For copies of any of these documents, please contact Roberta Stone, Ray Hecocta, or Sandra Petersen, 503-238-0667)

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CONGRESSIONAL WORKING GROUP
ON CHINA, CHAIR

March 11, 1993

The Honorable Gerry E. Studds
Chairman
House Merchant Marine and Fisheries Committee
1334 Longworth House Office Building
Washington, D.C. 20515

For inclusion in the proceedings of the hearing on watershed management practices and the role of hatcheries in the recovery of salmon populations.

Dear Mr. Studds,

The winter run chinook salmon are listed as "threatened" under the Endangered Species Act and "endangered" under California law. There is current consideration by the National Marine Fisheries Service to also list the species as "endangered" under federal law.

Because of this dire situation, I am writing to bring to your attention the Winter Run Chinook Salmon Captive Broodstock Program, a program to preserve the population of the winter run chinook salmon of the San Francisco Bay-Delta Estuary.

The winter run chinook has a unique gene adaptation to the Sacramento River. In the 1969 this species numbered more than 100,000 fish, enjoyed spawning grounds far upstream and flourished in a relatively healthy ecosystem. This has all changed and the chinook spawning population has declined to 191 fish in 1991.

The captive broodstock program is already underway. As of September 1992, 1,000 juvenile salmon are being raised in captivity for 3 years until maturity when they will be spawned and their progeny fish will then be returned to the wild. Research of the fish during the adult stages of their life history is also being conducted and has provided original methodology for genetic identification. The program has a projected 10-year life span, hopefully enough time so that habitat conditions can be sufficiently improved and the population can thrive once again.

The program has been implemented in order to genetically preserve the species by supplementing the natural population, and as part of a comprehensive and cooperative effort to restore water quality and a habitat that can support the natural wildlife of the region. Actions already taken to protect winter run habitat include: reduction of water diversion at the Glenn-Colusa Irrigation District, halting the release of striped bass

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in the Sacramento Delta, bypassing the powerhouse at Shasta Dam to provide cool water in the upper Sacramento River and monitoring the permit process for the dredging of the ports of San Francisco and Oakland.

This program is the result of a cooperative effort by representatives from the Department of the Interior, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Pacific Coast Federation of Fisherman's Associations, California Department of Fish and Game, California Department of Natural Resources, U.S. Bureau of Reclamation, California Water Commission, Golden Gate Sportsfisherman's Association, University of California Bodega Bay Marine Laboratory and the California Academy of Science's Steinhart Aquarium in San Francisco.

We have a problem in our region that encompasses the many different animals, plants, fish, rivers and streams that make up a complex ecosystem throughout the Bay-Delta Estuary. These problems need to be treated with a comprehensive, coordinated effort that aligns the policies of the different agencies involved. The Winter Run Chinook Salmon Captive Broodstock Program is an example of just such an effort.

I am currently in the process of drafting legislation that would authorize funding for the remaining nine years of the program and help to alleviate this serious problem for the Bay Area. Consideration of this authorization by your Subcommittee would be greatly appreciated.

Thank you for including my letter in your subcommittee's hearing record for March 9, 1993.

I look forward to working with you on this important project for the Bay Area.

Best Regards,

Nancy

Nancy Pelosi

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